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RESULTS OF TWENTY-ONE CASES OF SURGICAL TREATMENT OF ANEURISM

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Twenty-one patients with aneurisms, exclusive of thoracic and cirsoid aneurisms, were operated on at the Mayo Clinic, by various members of the staff, between January 1, 1907 and November 1, 1918. The type of aneurism, its location, the operation, and the results obtained are listed in the tabulation.

A complete cure was effected by operation in thirteen cases. In three of these, in which the aneurism involved relatively unimportant vessels, the operation consisted of proximal and distal ligation with excision of the sac. Four were proximal ligations only, three of the external carotid artery and one of the internal iliac artery. In one case a ligature was tied around the base of the sac. In three cases a Matas reconstruction endo-aneurismorrhaphy was done, two for aneurism involving the popliteal artery, and one for aneurism involving the femoral artery in Hunter's canal. In one case a compression suture was thrown around the communication in an arteriovenous aneurism. In one case the opening in the artery was sutured by opening the sac.

Improvement in one case was obtained by the Matas obliteration operation in a popliteal aneurism, in another by proximal ligation for an aneurism of the common carotid, and in another by a Neff clamp placed on the common iliac proximally to an aneurism on this vessel. One patient apparently was well for three years after proximal ligation of the subclavian artery for a subclavian aneurism and then he had a sudden recurrence. One patient was not improved by the proximal ligation for aneurism of the posterior tibial artery. There were three deaths in the series. One (Case V) occurred during an attempt to excise a subclavian aneurism which had been ligated two months before and had not been relieved by a proximal ligation. Death resulted from a cerebral embolus loosened by manipulation of the sac, as was shown at necropsy. One death (Case XII) was the result of cerebral changes following ligation of the common carotid artery and internal jugular vein, twenty-eight days after the application of a lead compression clamp to the internal carotid in a patient aged sixty-six, with an arteriovenous aneurism between the common carotid artery and cavernous sinus. The third

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death (Case XX) was probably due to circulatory disturbance; it followed the application of a Neff clamp proximal to an aneurism of the common iliac artery.

Residual disability due to circulatory disturbances in the extremity following the Matas operation on the popliteal artery persisted in one case. In this case there were some numbness and formication in the foot, but function was good and the trouble had practically cleared up eight months after operation.

The type of operation indicated and the time of surgical interference in each case depends largely on the location and type of aneurism to be dealt with, and especially on the efficiency of the collateral circulation. The latter factor may be estimated clinically, as pointed out by Matas[1]. In injuries to the large blood-vessels with threatened gangrene, Tuffier[2] has used arterial intubation with silver tubes and believes that in some cases gangrene may be prevented by allowing time for the establishment of collateral circulation before ligation of the injured vessel. Makins[3] states that aneurismal varices and arterial hæmatoma do not usually require early surgical treatment and in many cases are better if untreated. Surgical interference, however, is indicated if there is spreading infection of surrounding tissue, extension of blood effusion or external secondary hemorrhages, threatened gangrene of the limbs, or acute infection of the hæmatoma itself. Surgeons in the recent war found circular and lateral suture rarely practicable for obvious reasons, but successes are reported by Goodman[4], Haberer[5], and others. Proximal ligation, proximal and distal ligation, with or without excision of the sac, and in cases of arterio-venous aneurism, quadruple ligation, constitute by far the most common procedures reported for vascular injuries during the recent war.

In old traumatic and arteriovenous aneurisms, good results are obtained by proximal and distal ligation with excision of the sac, provided the vessels involved are small and their ligation will not cause disturbance of circulation to the periphery. In aneurisms of the large arteries, particularly of the femoral, popliteal, and posterior tibial, this method is extremely dangerous, for circulatory disturbances in the limb very frequently result even in young adults, as has been pointed out by Makins[3]. In such cases in which the collateral circulation is inefficient or doubtful, some operation that will leave the lumen of the vessel intact or interfere with the collateral circulation as little as possible, must be chosen. Ligation of the base of the sac, as performed by C. H. Mayo in Case XIII, is feasible for some cases. Passing an unabsorbable ligature about the point of anastomosis in arteriovenous aneurism may be done successfully, as illustrated by Case XVIII. The most practicable method, however, and the one that is the most often applicable, expecially in the lower extremity where a constrictor can be applied proximal to the lesion, is some form of the Matas operation. Halsted[6] prefers partial occlusion or extirpation when constriction cannot be applied, as in case of aneurisms of the iliac and subclavian vessels.

In the series herein reported satisfactory results were obtained in the four

cases in which the Matas operation was performed. The most successful operations in this series were proximal and distal ligations with excision of the sac when the aneurisms did not involve an important artery, and the Matas operation when a large trunk was involved. The results of proximal ligation were uncertain.

The results in these cases, although too few to be of great value in drawing conclusions, seem to indicate that double ligation and excision of the sac is the method of choice in cases of aneurism of the small arteries, since shutting off their blood supply is not followed by untoward results. The method of gradual occlusion with clamps gave only indifferent or poor results in the cases in which it was tried.

REPORT OF CASES: GROUPED ACCORDING TO TYPE OF OPERATION

PROXIMAL AND DISTAL LIGATION WITH EXCISION OF THE SAC (THREE CASES)

Case I (76029). Mrs. J. E. S., aged twenty-six, who was examined November 13, 1912, had been curetted seven months previously, three days after the birth of a child, because she had chills and fever. The fever subsided for five days and then returned. A second curettement was done and the patient became delirious with fever. This subsided, and a painful swelling appeared in the lower left side. Two other curettements were done with continuance of pain and chills. A surgeon was called who operated and found aneurism (?) of the uterine or internal iliac artery. The hæmatoma and the wound were drained and the patient recovered quickly.

At the time of examination at the Clinic the uterus was found to be slightly enlarged, with a soft swelling to the left. Pulsation and soft thrill were detected in the mass. The veins were not enlarged; the femoral pulse was equal. The mass extended below and seemed to be next to the vaginal wall on the left. A to-and-fro murmur with systolic accentuation was best heard over the left iliac fossa.

At operation November 16, 1912, an aneurism about 7 cm. long was found which extended downward from underneath the external iliac vein into the base of the left broad ligament, anterior to and beneath the ureter, so that it felt, through the vagina, like an aneurism of the uterine artery. By compression over the iliac veins it was found that pulsation could be stopped. A ligature was placed underneath the external iliac vein one-half inch from the external iliac artery, and the second ligature was applied 1.25 cm. to the inner side, but not completely distal to the aneurism. The proximal ligature was well approximated to the aneurism. The cavity was opened by cutting half way across its lumen; it was closed by catgut sutures. Large branches of uterine and vaginal arteries were cut and tied. The round ligaments were cut and the broad ligaments were opened from the top. The ureter was separated from the mass. The left ovary and tube showed signs of old inflammation. The tube was opened but it was not considered necessary to remove it. Catgut ligatures were applied. The broad ligaments were closed, and the appendix was removed. In this case a rather frequent anomaly was present; the obturator artery had its origin in the deep epigastrium, and passed behind the external iliac vein, with the deep epigastric, to a very short common stump. The aneurism may have been traumatic.

The patient had an uncomplicated convalescence. A slight numbness persisted in the left leg for a time, but gradually disappeared.

Case II (105740). Mrs. B. A. J., aged thirty-nine, had had a dull aching pain in the right shoulder and down the arms following an attack of grippe six years previous to examination at the Clinic, May 9, 1914. The trouble came in spells, usually one or two a year, lasting one or two weeks, but more frequent during the last year.

At examination a movable mass was found, not tender nor painful, in the right supraclavicular space. A diagnosis of supraclavicular glands was made.

Operation May 19, 1914, revealed an aneurism of the transverse cervical artery of the right side, which was excised. The patient's convalescence was uncomplicated.

Case III (80527). Mr. C. H. B., aged forty-three, was examined February 24, 1913. He had cut his right wrist with a piece of glass two years previously. A swelling appeared and became gradually larger for one year, then remained stationary.

Examination revealed a pulsating saccular tumor 3 cm. over the radial artery just above the right wrist.

At operation March 1, 1913, the radial artery was cut and both ends ligated. The patient was cured.

PROXIMAL LIGATION ONLY (NINE CASES)

Case IV (25528). Mr. S. E., a colored man aged forty-three, was examined June 29, 1909. He gave a history of having had syphilis when a boy, and of pain in the right shoulder and supraclavicular region for the past six months. Four months before examination he had noticed a pulsating tumor above the right clavicle, which gradually grew larger. The pain become more severe (intense during the last six weeks), and paræsthesia appeared in the thumb and forefinger.

Examination revealed a pulsating tumor in the right supraclavicular region somewhat below the clavicle. The radial pulse was weak in the right arm. The mitral systolic murmur was transmitted to the axilla, the aortic double murmur to the aortic area.

June 29, 1909, a ligation was done of the first portion of the right subclavian artery for subclavian aneurism. The convalescence was uncomplicated.

The patient remained well for three years and three months, when a large aneurism suddenly developed in the first part of the subclavian. The innominate artery was ligated elsewhere.

Case V (3876). Mr. J. B., aged fifty-eight, at examination November 9, 1907, gave a history of rheumatic pains in the right arm for the last two years, and for the last two months he had noticed a pulsating tumor under the right arm after exertion, more marked during the past month. The hand was numb. The patient had a hacking cough and shortness of breath.

At operation January 4, 1908, the third portion of the right subclavian artery was ligated.

The symptoms persisted and about two months later an attempt was made to remove the aneurism which involved the subclavian and axillary arteries. The operation was completed, except the applying of the proximal ligature to the subclavian, when the patient died of respiratory failure, due to a cerebral embolus which necropsy revealed to have been loosened in the manipulation of the aneurism.

Case VI (3855). Miss E. B., aged eighteen, was examined November 18, 1907. Five years previously she had been injured by a pair of scissors driven into the right ear. She had bled severely, and edema of the side of the face followed. For four years she had had throbbing pain in the right side of the face and back of the eye.

Examination showed dilated blood-vessels anterior to the right ear in the temporal region, and extending to the infra-orbital region. Palpable thrill and bruit and visible pulsation were present.

November 21, 1907, the right carotid was ligated for aneurism of the temporal artery. The aneurism was cured.

Case VII (97718). Mr. A. P., aged sixty-three, came to the Clinic December 27, 1913. One year previously he had noticed stiffness in stretching and some edema of the left leg, and on examination he found a mass in the thigh. The tumor enlarged

gradually and pulsation and pain became marked. For the last four months the right knee had been affected. The pain was worse at night.

Examination showed a large pulsating prominence extending from the femoral region in front, back into the buttocks. Palpable thrill was not noted, but bruit over the tumor. The tumor was compressible and expansile. The right knee was flexed, with some swelling and periarticular thickening. The Wassermann test was negative. Röntgenograms revealed blurring in the region of the left hip, practical absence of the tuberosity of the ischium and rami, and an eaten-out area in the posterior third of the lower right femur.

A transperitoneal operation was done January 6, 1914, with ligation of the left internal iliac artery for an aneurism about 10 cm. in diameter on the inner side of the left thigh. The aneurism was thought to be in the obturator artery. Thrill was present in the internal iliac but not in the external. The ureter and peritoneum were pushed to one side and the vessel was ligated at its origin with two heavy silk ligatures. The pulsation ceased immediately. The aneurism was stilled when the patient was dismissed from our care a fortnight later.

Case VIII (204134). Mrs. J. E. C., aged forty-three, was examined August 6, 1917. For ten years she had had a lump on the left side of the throat which was thought to be due to enlarged tonsils. The patient had had goiter for many years. Three months previous to examination the mass became larger and began to drain. A month later a doctor was consulted who pronounced the condition to be a sarcoma.

Examination showed a protrusion of the left pharyngeal wall. Thrill internally, bruit externally, and pulsation were noted. There was a fusiform swelling of the angle of the jaw on the left without bulging in the larynx. A diagnosis was made of adenoma of the thyroid.

At operation August 20, 1917, an aneurism of the left external carotid was found. The aneurism began just at the bifurcation, and was separated with difficulty from the internal carotid. However, the external carotid was ligated with a double strand of silk and a double strand was passed around the common carotid, in case there should be bleeding; this was removed later. The convalescence was uncomplicated, and the aneurism was apparently cured when the patient was dismissed from the hospital.

Case IX (80021). Mrs. R. G., aged twenty-six, came for consultation February 14, 1913. Six years previously bleeding from the right ear had commenced and shortly afterward she became deaf and noticed what she supposed to be a growth in the canal of the ear. One year later she began to have pain in the ear, and an operation was performed to remove the growth. Right facial paralysis that was slight before operation became complete. One year after operation the original symptoms reappeared, with severe pain in the head, throbbing, dizziness and fainting spells. Occasionally the spells of bleeding from the right ear were severe and lasted several days.

Examination revealed a pulsating tumor in front of the right ear, and one of the left submaxillary and carotid regions. The patient could open her mouth only slightly. A diagnosis was made of an aneurism of the right external carotid artery, and possible aneurism inside the skull involving the right lateral sinus, also aneurism of the left internal carotid extending down to the common carotid.

The external carotid artery and the internal jugular vein were ligated on the right February 20, 1913. Six days later the common carotid artery on the left just below the bifurcation was ligated for aneurism, which apparently involved the left internal and external carotids. The external and internal jugular veins were ligated. The patient made an uninterrupted recovery, and was relieved from the pain, throbbing, and pulsation in the side of the head. The bulging was still present

in the left side of the neck two months after the operation, but there was no pulsation. There was still a slight discharge from the right auditory canal.

The patient was heard from one year after operation. She had no signs of a recurrence of the aneurisms.

Case X (81010). Mrs. R. B. B., aged fifty-one, had had two attacks of hyperthyroidism, seventeen and four years respectively, previous to examination in the Clinic March 6, 1913. The patient had noticed throbbing in her neck during the last attack, which gradually became worse. An exploration was done elsewhere for aneurism of the thyroid and a diffuse aneurism of the carotid was found. Since then she had had pressure in the neck and a feeling of fullness in the head. For the past six months there had been a dull ache in the right arm. Examination revealed a pulsating aneurism of the right carotid about 3 cm. in diameter, 2.5 cm. above the clavicle.

Operation was performed March 10, 1913, when the middle portion of the right carotid was ligated. Some dilatation followed at the site of ligature, and more below. The patient improved. Slight giddiness still persisted but the dilatation decreased, especially at the upper end. The pulsation persisted.

Case XI (80582). L. H., a boy, aged sixteen, was examined February 25, 1913. Ten years before his right foot had been stepped on by a horse, but there had been no lasting discomfort from the injury. Four years later a painful enlargement appeared in the arch of the foot. This gradually grew worse, at times confining the patient to bed. Some relief was afforded by an arch support.

Examination showed the left foot to be enlarged and puffy, with apparent engorgement of the veins below the ankle. Occasionally a thrill and bruit synchronous with the pulse were present over the inner aspect of the tendo achillis. The right calf measured fifteen inches, the left calf fourteen; the right thigh eighteen and one-half inches; the left thigh sixteen and three-quarter inches; the right knee fourteen and one-half inches; the left knee fourteen inches.

March 3, 1913, a ligation was done of the posterior tibial artery and accompanying veins of the varicose aneurism of the left posterior tibial artery above the right ankle.

Repeated examination after operation showed the condition of the foot and leg to be practically the same as before. In twenty-eight days the bruit, thrill and local perspiration were absent. The varicosities in the arch were still present. The patient was forced to wear an elastic bandage. On reëxamination two months after the operation the patient was no better. Blood rushed to the leg when he stood, and it was still swollen. Ten months after the operation the condition in the leg was practically unchanged, but thrill and bruit were not present and the swelling was not so marked. Fifteen months after operation the foot was almost normal, but the patient still complained of pain in the leg. Ten days previous to this last report, while the patient was removing the elastic bandage, he felt a sensation as of something giving away in the calf of the leg, with severe pain which persisted. The patient was sent home and told to rest. He returned again in two months, at which time a diagnosis of popliteal aneurism was made and an operation advised which the patient refused.

Case XII (67951). Mrs. A. E. B., aged sixty-six, came to the Clinic May 20, 1913, with a history beginning with drooping of the left eyelid three years before; in a few months complete ptosis occurred. The eyeball had been paralyzed completely for the last two years. About six months before examination the patient had begun to have attacks of pain around the left eye and in the cheek and head, with constant pounding in the left side of the head, the attacks lasting from ten to twelve hours. She vomited every few minutes. In the last few weeks there had been a prickling sensation in the lower jaw, in the left side of the tongue, and in the left side of the roof of the mouth.

Examination revealed complete ophthalmoplegia of the left eye, third, fourth, and sixth nerves, and some sensory disturbance of the fifth nerve. The left eyeball was proptosed; the discs were distinctly hazy. Vision in the left eye was 20/40, in the right 20/70. The tonometer showed equal tension in both eyes. The röntgenogram revealed absence of the posterior wall of the sella turcica.

May 27, 1913, a lead clamp was placed on the left common carotid and compressed until a very faint pulsation beyond the clamp was noted. The internal carotid apparently was enlarged to about twice its normal size. Four days later the left common carotid was again partially occluded with the lead clamp which had spread. At a third operation the vessel was completely occluded by placing a forceps on the lead clamp. The common carotid was ligated twenty days after the occlusion with the clamp. The lead clamp had cut entirely through the artery. About 2.5 cm. was cut on either end and the ends ligated. The jugular vein on the left was divided and ligated. The lead clamp was not found. The patient died nine days after the ligation of the left common carotid and the internal jugular vein. Necropsy was not obtained.

LIGATURE ABOUT THE BASE OF THE SAC (ONE CASE)

Case XIII (3724). Mr. G. W. H., aged twenty-four, registered at the Clinic November 13, 1907. Nine years previously he had sustained a buckshot wound in the right groin. An attempt was made at the time to remove the shot. The wound healed in seven weeks, but the region over the wound remained tender. Six months before examination the patient noticed aching of the muscles of the right calf when he walked, and for two weeks he had had difficulty in getting about. Three years before he had had typhoid with phlegmasia alba dolens of the right calf, and ulcers. Since then the right calf had been larger than the left.

Examination revealed an expansile tumor just above the groin on the right, with bruit over the femoral artery; the tumor was visible with expansile pulsation.

At operation November 13, 1907, a saccular aneurism of the right external iliac artery was found. The sac was ligated at the base with No. 4 catgut. The patient's recovery was uneventful. Six years later he was operated on for right hydronephrosis. No signs of aneurism were noted at this time.

MATAS OPERATIONS (FOUR CASES)

Case XIV (48801). Mr. G. C., aged thirty-four, had been shot with a revolver five weeks before he was examined at the Clinic February 2, 1911. The bullet entered below the knee and came out on the external surface of the middle third of the thigh.

At the time of examination a pulsating fusiform tumor about 8 cm. in diameter was found bound down in the popliteal space. Extension of the leg caused pain beneath the knee. A continuous fine thrill with systolic accentuation on auscultation was heard over the tumor.

A Matas operation was performed February 9, 1911. The aneurism was closed with two rows of chromic catgut. Following the operation the leg swelled slightly, but the swelling disappeared almost completely later and the ulcers healed. The leg swelled again for a time after operation. The patient's condition was much improved.

Case XV (94352). Mr. G. W., aged forty-two, was examined October 24, 1913. He had had a chancre (?) or lesion on the penis nine years previously, but no secondary manifestations of syphilis. Three weeks before examination he had noticed a small hard pulsating mass in the right popliteal space. Pulsation was transmitted to the foot. The mass increased in size, more noticeably after he had been standing. He had pain down the back of the leg, and some difficulty of extension,

Examination revealed a mass at the right popliteal space, movable with the tissues and with forcible pulsation. Total inhibition Wassermann persisted after three injections of salvarsan.

At operation November 17, 1913, a saccular aneurism at the right popliteal artery was found extending along the artery for about 2.5 cm. There was sufficient good intima in the sac to warrant the reconstructive endo-aneurismorrhaphy operation, which was done after the Matas method. At the close of the operation the foot had a good color and the pulse was obtainable in the tibial artery. The leg was in good condition six weeks after operation, when the patient was discharged from the Clinic.

Case XVI (25936). R. S., a boy, aged sixteen, who was examined July 8, 1909, gave a history of having been shot in the left thigh five years before; the wound had healed quickly. One and one-half months before examination rheumatic pain developed in the left ankle, in the knee, and in the region of the wound, and the thigh began to swell. On exertion the leg became numb and dull pain extended from the ankle tumor to the inner side of the knee.

Examination revealed a tumor just above the knee on the inner surface, to be expansile and pulsating. The left anterior tibial pulsation was very faint. There was slight ecchymosis over the tumor. At operation July 8, 1909, an aneurism of the left femoral artery was found in the upper end of Hunter's canal. A large superficial artery running over the tumor was evidently making collateral circulation. A reconstructive operation (aneurismorrhaphy) was done. The opening in the artery was closed with linen sutures. There were no complications and the patient was dismissed on the twenty-second day with the leg in good condition.

Case XVII (141305). Mr. T. A. C., aged twenty-nine, came to the Clinic July 16, 1915. He had been shot in the left leg in the region of the knee eleven years previously; the bullet had been removed. Varicosities had been present since the injury. Seven years later the leg swelled and the veins enlarged and became ulcerated. The swelling and numbness were less at night and when the patient was off his feet. He had worn a rubber stocking for two and one-half years.

An arteriovenous popliteal aneurism was found in the lower left popliteal space, varicose veins of the leg, and scars of former operations for varicose veins.

At operation, September 25, 1915, a sac 5 cm. long and irregularly oblong in shape was found. Into this a dilated vein and a normal sized artery emptied, above and below, making four openings into the sac. The veins were ligated and the artery reconstructed after the method of Matas. The arterial wall was hard and contained small calcareous flakes. The sac was sutured where branches of the artery were torn off from its friable wall.

Following the operation the ulcers persisted for eight months, and there was slight numbness of the leg. Thrill was noted with extreme flexure. On the whole the patient was greatly improved.

SILK FIGURE-EIGHT SUTURE ABOUT ANASTOMOSIS (ONE CASE)

Case XVIII (159911). Mr. I. A. M., aged thirty-five, was examined at the Clinic May 17, 1916. He had been shot with a thirty-eight caliber revolver in the upper right chest nine years previously. Very severe hemorrhage occurred, and the patient was in a hospital for three months. There had been more or less constant swelling and gradual development of varicosities of the left arm. For the past two or three months there had been swelling of the forearm, and frequent cramps, especially when the arm was used. The swelling under the clavicle did not increase.

The left arm and shoulder were found to be greatly swollen; the veins in the left axilla and the chest wall were varicosed. Under the left clavicle, 10 cm. from the midline, a soft pulsating tumor was palpated. Thrill was noted and a loud systolic murmur was heard over the tumor.

Operation was performed May 23, 1916. The pectoralis was removed. The left subclavian vein was distended to about 5 cm. in diameter from the sterno-clavicular angle out into the arm. The vein was doubly ligated proximal to the subscapular vessels. All the veins which acted as arteries had greatly thickened walls. The superficial vessels were ligated between the sternoclavicular angle and the point of ligation of the subclavian vein. A figure-eight compression suture was placed over the point of arteriovenous anastomosis, which is about 4.5 cm. from the left sterno-clavicular angle. Hemorrhage was severe on account of the bleeding from both arteries and veins. Two tube drains were inserted. The arm before operation was about twice the normal size, blue and congested, with veins standing out over the left side of the chest, the left shoulder, and arm. Following the operation there was a marked change; the swelling was reduced one-half during the first twenty-four hours and the condition of the arm improved steadily. The patient was discharged one month after the operation able to use his arm.

PARTIAL EXCISION OF THE SAC AND SUTURE OF OPENING IN ARTERY (ONE CASE)

Case XIX (232671). Mr. H. K., aged thirty-eight, fifteen months before examination in the Clinic May 29, 1918, had been shot at close range with a twenty-two caliber rifle. The bullet entered the thigh 10 cm. above the knee on the median surface, and passed out, posterior to the bone, at a corresponding level on the outer surface. Some hemorrhage had occurred and the patient was in bed for two weeks with the leg greatly swollen back of the knee. Later the lower leg and foot became swollen, and about nine months after the injury the skin became darkened and eczematous, and several small ulcers appeared.

The leg presented the typical symptoms of an arteriovenous aneurism. Just above the external condyle was a soft pulsating swelling, the size of an egg, and in the center of it the wound of exit. Expansile pulsation with a marked thrill and venous hum over the mass and marked diffuse swelling of the popliteal space were present. The dorsalis pedis on both sides was palpable, but the posterior tibial vein at the ankle was not found. The aneurism was stilled by compressing the femoral artery in Hunter's canal.

Operation was performed June 6, 1918. An oblique posterior popliteal incision was made. The popliteal veins 2.5 cm. in diameter were isolated and separated above and below the anastomosis of the artery to the vein. In passing a ligature around the anastomosis the sac was pricked, which caused considerable hemorrhage. An effort was then made to ligate with silk, but because the anastomosis was large it was impossible to close it in this manner. The sac, which was on the venous side and opposite the opening between the artery and the vein, was dissected out and part of it cut away. The opening between the artery and vein, about 2.5 cm. in length, was closed by suture with catgut. The vein was ligated distally with silk, and without drainage. Following the operation there was complete cessation of pulsation, thrill and bruit, and in twenty-four hours the swelling had greatly decreased. The dorsalis pedis was palpable. The patient was able to use his leg when he was discharged from the hospital fifteen days after operation.

APPLICATION OF NEFF OCCLUSION CLAMP (TWO CASES)

Case XX (61582). Mr. C. F. B., aged twenty-eight, who was examined November 27, 1911, had been operated on elsewhere six years before for right inguinal hernia. For the last year the patient had had a throbbing sensation in the right abdomen about 5 cm. above the hernial wound. Three weeks before examination, and occasionally since, when he lifted any weight, he had had a sharp, stabbing pain above the hernial scar. Otherwise he felt well.

When the patient was examined, a pulsating mass in the lower abdomen, slightly to the right side, was noted. The pulsation in the right femoral artery was normal; in the left it was absent; bruit was felt over the mass. The lower abdominal veins were enlarged. The right leg was somewhat larger than the left.

TABULATION

DATA ON TWENTY-ONE CASES OF ANEURISM

Case	Artery involved	Type of aneurism	Operation	Results
I	Obturator, left........	Traumatic....	Proximal and distal ligation with partial excision of sac....	Cure. Anomalous origin obturator artery.
II	Transverse cervical, right...............	Pathologic....	Proximal and distal ligation with excision of sac................	Cure.
III	Radial, right..........	Traumatic....	Proximal and distal ligation with excision of sac	Cure.
IV	Subclavian, right......	Pathologic....	Ligation first portion subclavian artery.......	Well three and one-fourth years, then sudden recurrence.
V	Subclavian, right and axillary.............	Pathologic....	Ligation third portion right subclavian. Attempt at excision 2 months later.........	Death, on attempt at excision, due to cerebral embolus from sac.
VI	Superficial temporal, right.............	Arteriovenous.	Ligation external carotid	Cure.
VII	Obturator (?), left.....	Pathologic....	Proximal ligation internal iliac artery........	Cure. No signs of aneurism sixteen days post-operative.
VIII	External carotid, left..	Pathologic....	Proximal ligation external carotid........	Cure.
IX	External carotid, right. Interal carotid, left..	Pathologic....	Proximal ligation, right external carotid. Ligation right internal jugular vein. Proximal ligation left common carotid and left internal and external jugular veins........	Cure. No recurrence one year later.

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X	81010	Common carotid, right.	Pathologic, diffuse	Proximal ligation common carotid artery	Improvement.
XI	80582	Posterior tibial, left.	Pathologic (?), diffuse	Proximal ligation posterior tibial artery	No improvement.
XII	67951	Internal carotid and cavernous sinus, left	Arteriovenous.	Lead compression clamp to internal carotid artery. Occlusion artery completed four days later. Ligation common carotid and internal jugular vein twenty-eight days after occlusion internal carotid artery	Death from cerebral changes nine days after last operation.
XIII	3724	External iliac, right.	Traumatic, saccular	Ligature: No. 4 catgut tied about base of sac.	Cure. Patient well six years after operation.
XIV	48801	Popliteal, left.	Traumatic.	Matas obliteration, endoaneurismorrhaphy	Improvement. Some swelling of leg.
XV	94352	Popliteal, right.	Pathologic, saccular	Matas reconstructive operation	Cure. Leg in good condition.
XVI	25936	Femoral, left, in Hunter's canal	Traumatic.	Matas reconstructive operation	Cure.
XVII	141305	Popliteal, left.	Arteriovenous.	Matas reconstructive operation. Ligation popliteal vein	Cure. Some numbness.
XVIII	159911	Subclavian, left third portion	Arteriovenous.	Silk figure-of-eight suture about anastomosis	Cure. Swelling disappeared.
XIX	232671	Popliteal, left.	Arteriovenous.	Partial excision of sac and suture opening in artery	Cure.
XX	61582	Common iliac, right.	Pathologic (?), saccular	Neff clamp to common iliac proximally	Death from circulatory disturbance 4 days post-operative.
XXI	62336	Femoral, left.	Pathologic, diffuse	Neff clamp to left common iliac artery	Improvement. Reduction of swelling.

December 29, 1911, an extraperitoneal working incision and an intraperitoneal incision for exploration was made. A saccular aneurism which started at the beginning of the common iliac artery was found. A Neff occlusion clamp was set on the right common iliac 2.5 cm. above the beginning of the aneurism; the clamp was closed down to very faint pulsation below. The sac of the aneurism occupied nearly the entire pelvis and interfered with the circulation in the left leg. The patient vomited for the first twenty-four hours. The pulse was 130 for several hours after the operation and then varied between 130 and 162. The color of the right leg was good for two days, but the pain in it was severe. The patient died, probably of circulatory disturbances, the fourth day after the operation.

At necropsy a large saccular aneurism of the right common iliac artery, beginning about 6 cm. below the origin of the common iliac and extending to about the beginning of the femoral was found. The Neff clamp was in place 3 cm. below the bifurcation of the aorta.

Case XXI (62336). Mr. G. M., aged twenty-seven, came to the Clinic December 16, 1911. Eleven years before he had had a sudden onset of severe pain above the left knee; the region became red and swollen. The patient was confined to bed for six months. Four months after the onset of the pain an incision was made with the evacuation of pus, but the pain continued. At the end of four months the bone was scraped. The wound healed, but the leg above the knee swelled. The patient thought that a large vessel in the leg had been injured or cut at the second operation. Ulcers had appeared, but they healed in six weeks. Eight weeks before examination the patient began to have pain, more severe after standing, in both sides and above the knee.

Examination revealed a varicose condition above and below the knee; the leg and knee were slightly swollen. A rough bruit was felt and heard in the popliteal and adductor regions, with pulsation in the posterior tibia and anterior tibia at the ankle.

At operation December 28, 1911, a diffuse dilatation of the entire left femoral artery, extending beyond Poupart's ligaments, was found. The incision in the thigh was closed and eleven days later an abdominal exploration (transperitoneal exposure) was done. A Neff clamp with several rolls of catgut, held together with a rubber elastic, was placed on the left common iliac artery at its origin. The peritoneum was stitched over the clamp. Following the operation a tuberculous abscess developed at the site of the old osteomyelitis scar. This was drained and cleared up. Chills and high temperature had preceded the appearance of the abscess. The patient had improved at the end of two and one-half months, but the thrill was still present and some swelling of the leg.

BIBLIOGRAPHY

[1] Goodman, M. C.: Suture of blood-vessel injuries from projectiles of war. Surg., Gynec. and Obst., 1918, xxvii, 528-529.

[2] Haberer, H. v.: Diagnose und Behandlung der Gefässverletzungen. Münch. med. Wchn-schr., 1918, lxv, 405-409.

[3] Halsted, W. S.: The effect of ligation of the common iliac artery on the circulation and function of the lower extremity. Report of a cure of iliofemoral aneurism by the application of an aluminum band to that vessel. Bull. Johns Hopkins Hosp., 1912, xxiii, 191-220.

[4] Makins, G. H.: On the vascular lesions produced by gunshot injuries and their results. Brit. Jour. Surg., 1915-1916, iii, 353-421.

[5] Matas, R.: Surgery of the vascular system. In: Surgery (Keen), Saunders, Philadelphia, 1911, v, 17-350.

[6] Stewart, J. P.: A clinical lecture on ischemic myositis. Brit. Med. Jour., 1918, ii, 151-153.

[7] Tuffier: Intubation artérielle substitué à certaines ligatures immèdiates des gros baisseaux. blessés. Presse méd., 1915, xxiii, 416.

TRANS-ORBITAL PUNCTURE OF THE GASSERIAN GANGLION*

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Direct injection of the fifth cranial nerve has been so closely associated with the therapy of trigeminal neuralgia, that their histories are almost identical. Indeed, this procedure has but one competitor in the treatment of the disease. The contest for supremacy between " chemical neurectomy " and operative neurectomy has been fought for thirty-five years. Although operative neurectomy is undoubtedly the method of choice at present, a conservative view must concede the possibility that further observations and improvements in the technic may reverse this decision.

In any event, as a stimulus to further development of needle puncture of the trigeminus, we have the problem of nerve block anæsthesia for operations on the head, face and buccal cavity. Although the development of intratracheal insufflation anæsthesia has reduced enormously the mortality of operations in these regions, elaborate apparatus is required and the method is seldom employed. It is to be hoped, therefore, that any effort to improve and simplify the technic of the injection of the trigeminus will be valued not only for the help it may afford in the therapy of trigeminal neuralgia, but also because of its obvious usefulness in nerve block anæsthesia for the difficult technical operations within the zone of distribution of the fifth nerve. Indeed, this is probably its most fruitful field of usefulness.

HISTORICAL

In tracing the history of needle puncture of the trigeminus we find three developmental stages—first, a time when injection was made into the peripheral branches of the nerve; second, a time when the operator became more daring and directed his needle to the main nerve divisions at the base of the skull; and finally, a time when the needle was passed into the Gasserian ganglion itself, in order that the nerve cells might be infiltrated. Rynd (1840) was responsible for the first peripheral injection. He advocated the use of morphine and creosote for this purpose. The result was not sufficiently striking to secure the introduction of the method, and the procedure had to await the discovery of a drug better adapted to this purpose than creosote. A great many were tried and rejected, and it was not until 1874 that this form of therapy became firmly established by Bartholow with the injection of chloroform. Osmic acid was then used by Billroth (1884), Neuber (1884), Eulenberg (1884) and Schapiro (1885). The technic was simple but the results quite uncertain, and it was frequent to get disfiguring

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scars due to tissue necrosis. At best, relief from pain was no more lasting than that resulting from nerve avulsion. For a period attention was diverted from injection therapy to extirpation of the ganglion by open operation, elaborated by the brilliant work of Hartley, Krause and Cushing. There was little doubt as to the efficiency of gasserectomy in the permanent relief of neuralgia, but the operation as executed in those days was subject to an almost prohibitive mortality from hemorrhage and shock.

The second stage of trigeminal puncture was inaugurated by Schlösser (1903), director of the Eye-clinic in Munich. By investigations upon cadavers, he elaborated a technic whereby a needle could be inserted through the cheek to the foramen ovale at the base of the skull. And he used this technic for the injection of alcohol into the mandibular division in two hundred cases of trigeminal neuralgia (1906 and 1907). In his hands the treatment was easily administered and the relief fairly certain, but the method required the knowledge of a trained anatomist and the skill of a specialist for its execution. With the way thus opened, there soon appeared other methods for needle approach to the basilar foramina, chief among which were the technics of Ostwalt (1906) and of Levy-Baudouin (1906). Whereas, Schlösser had been able to inject the third division only, Ostwalt, by entering the needle through the mouth, was able to reach in succession in a single puncture the foramen ovale, the foramen rotundum and the sphenoidal fissure, and thereby to apply treatment to any of the three primary divisions of the trigeminal nerve. This, too, required great skill in its management, and in addition was open to the danger of septic inoculation from the mouth. Levy and Baudouin employed separate punctures for each of the three divisions. Their technic is the one practiced most widely at present for this purpose.

No matter how thorough the injection of one of these nerve trunks and how complete the resulting anæsthesia, in a large percentage of cases sensation returns from eight to ten months after treatment, for, although death of the peripheral nerve segment is produced by the alcohol, continuity of the nerve sheaths is not disturbed, and regeneration readily occurs. Consequently an effort was soon made to destroy the nerve cells by injection of the Gasserian ganglion, the third stage in the history of trigeminal puncture. Wright (1907) exposed the foramen ovale by open operation in an obstinate case of facial neuralgia, and passed a needle through the foramen into the ganglion. Chollin (1907), using the Ostwalt intrabuccal technic upon the cadaver, succeeded in entering the foramen and placing an injection of methylene blue directly in the ganglion. As a result of experiments upon the cadaver, Byrnes (1909) modified the methods of Schlösser, Ostwalt and Levy and Baudouin in such a manner that by use of any one of them the Gasserian ganglion might be reached. But none of these investigators applied their work clinically, and it is to Pussep (1911) that credit is due for being the first to place alcohol in the Gasserian ganglion of a living subject by transcutaneous needle puncture. The experi-

ment was very nearly fatal to the patient, for vomiting, cyanosis, bradycardia and collapse immediately followed the injection—and the operator, aghast at the picture presented, denounced the procedure as far too dangerous for justification. Perhaps this unfortunate experience might have delayed the progress of Gasserian puncture, had it not been for an accident on the part of Taptas (1911), of Constantinople. While attempting to inject the third division of the trigeminal nerve at the foramen ovale by the Levy-Baudouin approach in a case of tic douloureux, Taptas inadvertently slipped the needle through into the ganglion and injected alcohol. The result was profound anæsthesia in the entire trigeminal field and permanent relief from pain. The patient suffered no ill effects. And we find in the literature shortly after this, descriptions of two methods completely elaborated upon cadaver and living subject, whereby the needle may be made to enter the ganglion. The first of these is the invention of Wilfred Harris (1912), Physician to Saint Mary's Hospital, London, and is based upon the original Levy-Baudouin approach to the third division. Fritz Härtel (1913 and 1914), of Berlin, is responsible for the second, which is in principle none other than the puncture of Schlösser. Both Harris and Härtel used the foramen ovale as a pathway to reach the ganglion. These are now the classical methods for intraganglionic injection.

THE HARRIS TECHNIC

Harris described his method as follows: "I use a moderately stout, hollow needle 1.2 mm. in diameter, with a short point, without a stylet. This is pushed through the cheek below the zygoma, on a line joining the ala nasi with the incisura notch of the ear, and about 1¼ inches in front of this notch. If pushed in horizontally the point of the needle will sometimes strike the ramus of the mandible just below the sigmoid notch, but depressing the handle of the needle slightly will allow the point to slip through the lowest level of the sigmoid notch into the zygomatic fossa. Directing the needle slightly upwards and backwards the base of the skull will be reached at a depth of about 1¼ inches, the point of the needle striking the under surface of the great wing of the sphenoid. The handle of the needle must then be depressed and the point of the needle be made to slide along the bone until it engages in the foramen ovale, at a depth usually of 1¾ inches. In some skulls the needle must be directed more upwards, as high as 30 degrees upwards, and in others it must be directed at the same angle backwards. If this needle is pushed in too horizontally the wall of the pharynx will be pierced at a depth of from 2 to 2½ inches, or again if it be pushed too far through the foramen ovale, the cavernous sinus and internal carotid artery will be punctured. To avoid this the needle should never be passed through the foramen to a greater depth than 2½ inches from the surface. . . ." As soon as the needle touches the nerve at its exit from the foramen ovale, as indicated by a sharp pain referred to the lower jaw, 0.5 c.c. of a 2 per cent. solution of novocain is injected to test the position of the needle, before alcohol is used (1.5 c.c. of 90 per cent. alcohol). Fluid thus placed in the foramen ovale usually flows upwards a variable distance along the nerve trunk into the Gasserian ganglion, and infiltrates the root of the third division. "But if the second division is also affected by the pain, then more of the ganglion must be destroyed and the needle must be worked through the foramen into the substance of the ganglion to the depth of another quarter of an inch. A drop of alcohol is

then cautiously injected, considerable resistance to the push on the piston being experienced if the point of the needle remains within the new tissue. Another 1.0 to 1.5 c.c. of alcohol should then be injected, a few drops only at a time, at intervals of not less than two minutes, meanwhile testing the sensation of the cheek and forehead with a blunt pin. When neither the pressure of the head of the pin or the sharp prick on the forehead is any longer perceived at all, enough has already been done and the needle should be slowly withdrawn." General anæsthesia is not used. The skin at the point of entrance is anæsthetized by local infiltration or by freezing.

The following account is translated from Härtel's (1913) article: "An assistant steadies the head of the patient. The operator places his left forefinger in the patient's cheek, and with the jaw closed searches for the fissure between the maxillary tubercle and the ramus of the mandible. With the marker of the needle adjusted at 6 cm., the needle is passed into the cheek at a point 2 cm. lateral to the angle of the mouth, until it comes in contact with the hard, smooth surface of the infratemporal plate. Now the finger is removed from the cheek, the marker on the needle has come to lie on the cheek surface. The marker is withdrawn a distance of 1.5 cm. from the skin as an indicator of the further depth required. With the face of the operator directly over the up-turned face of the patient, the needle should be situated in a plane passing through the pupil on the same side. Now the needle is grasped as though it were a pencil, and by repeated partial retractions and insertions, search is made backwards along the bony surface. One should not travel with the needle point more posteriorly than that angle at which the needle is directed toward the auricular tubercle of the zygoma. What was up to this point a painless procedure now becomes painful, for we are approaching the vicinity of the third division and its branches. After a few trials here and there against the surface of the skull, the needle passes over the anterior rounded margin of the foramen ovale and is no longer confronted by bony resistance, but instead by the dense consistency of the nerve tissue filling the foramen. It is advanced into the skull until the marker is brought flush with the skin surface (an intracranial distance of 1.5 cm.). If bony resistance continues to offer, either the needle is in the foramen ovale but in a wrong axis to enter its canal, or it has travelled posteriorly onto the inferior surface of the petrous portion of the temporal bone (Eustachian tube). Draw the needle out immediately and repeat the puncture at a new point of entrance or in a different axis. With the needle supposedly in the ganglion substance, 0.5 c.c. of 2 per cent. novocain solution is injected, in order to test the accuracy of the puncture and to guard against the serious consequences of alcohol placed elsewhere than in the nerve. If the desired trigeminal anæsthesia is the result, alcohol injection is begun slowly with careful watch for loss of corneal reflex, the first sign of a successful ganglion injection. During the process of the injection the needle point is worked about in the ganglion substance, to secure as thorough an infiltration as possible." Härtel uses for this puncture a hollow steel needle 10 cm. in length and 0.8 mm. in diameter, without a stylet. This needle is quite flexible, its advantage over the heavier needle of Harris lies in reduced damage to the tissues. However, its flexibility makes lateral movements impossible, and search for the foramen must consist in a succession of punctures.

Nine years have elapsed since these two prevailing methods of needle puncture of the Gasserian ganglion were first attempted clinically. They have both been used in this country in the treatment of tic douloureux by Grinkler (1913), Maes (1913), Camp (1914), Byrnes (1915), Vaughan

(1917) and many others. In reviewing the literature that has accumulated one cannot help but be impressed with the diversity of opinion held by competent men as to the facility with which ganglion puncture is performed. There are those who find but little difficulty in placing the needle within the ganglion. Dorrance (1916) states that he " gets in the first or second time, and it comes easy after doing a few." Martin (1918) feels that " the injection of the ganglion of Gasser through the foramen ovale for the relief of trigeminal neuralgia has passed beyond the experimental stage and will eventually supersede surgical extirpation of the ganglion, division of the sensory root, peripheral and nerve trunk injection, and other more or less unsatisfactory procedures." But the majority hold more regard for its uncertainties and dangers; and a few are so pessimistic as to pronounce it utterly unjustifiable. Patrick (1916), who has had a very considerable experience with injections into the divisions of the nerve, expresses but little enthusiasm in regard to ganglion puncture. " I must say that under the rules Härtel himself originated, I never had the courage to attempt to inject the Gasserian ganglion. . . . Injection of the ganglion by the Harris method is disappointing to me. I have tried it a number of times; occasionally the needle goes through the foramen and reaches the Gasserian ganglion or its vicinity with a facility comparable to putting one's hand in ones's pocket. And the next time the needle does not find the foramen at all." There is no easily recognized pathway to the foramen. The operator must depend upon the sense of direction only in passing his needle through the soft tissues of the cheek and zygomatic fossa to bone 4 to 7 cm. beneath. He aims to hit a target whose average diameters are 3.5 and 6.6 mm. A deviation of but three degrees is necessary to deflect the needle point from the centre of the foramen onto the adjacent surfaces. On account of the variations to be found in normal skulls chances of a hit are even less than this. It has been found, for instance, that the distance of the foramen ovale from the zygoma may show a variation of more than a centimetre. Often an attempt to enter the ganglion becomes little else than a hunt in the dark. Moreover, the practice of probing along the base of the skull in quest of the foramen is not simple, for, as Patrick (1912) points out, " the under surface of some skulls is very uneven and the irregular and unnamed processes serve to confuse the operator; he feels bone everywhere." When the needle has entered the foramen successfully and is passing on into the ganglion, there is nothing to indicate its exact position within the skull, except the patient's statements in regard to his sensations, or trial injections of novocain, or arbitrary rules as to depth. Movements of the needle within the ganglion are not always represented in an accurate manner by pain referred to the surface, nor is the patient able in every case to describe his sensations adequately. Test injections serve as an accurate sign of a successful puncture, but on the occasion of an unsuccessful attempt such a preliminary injection must necessarily render the tissues less sensitive and mask the signs relied upon for further search. Härtel directs that the needle point be carried

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1.5 cm. beyond the foramen for a correct localization in the ganglion; and Harris that the depth should be but a few millimetres. These rules cannot be reliable. Härtel (1913) himself has shown by measurements upon sixty skulls that the foramen ovale is not simply an aperture but a canal of variable length; that the distance of the lower margin of the ganglion from the foramen ovale may vary as much as 10 mm.; that the superior margin of the petrous portion of the temporal bone lies anywhere from 14 to 23 mm. beyond the foramen. Moreover, the Gasserian ganglion is a very much flattened structure, and is so situated that its narrow margin is presented to a needle entering the foramen ovale. Should the needle be introduced in a plane nearer to the vertical than that of the ganglion, it may readily enter the foramen, but instead of proceeding on into the ganglion, it will enter the subarachnoid spaces above it. Or should the needle pass in a plane nearer to the horizontal, it will probably burrow beneath the ganglion capsule, where injection may be made without effect.

Not only are these two methods uncertain in execution, but there are dangers to be considered. The zygomatic fossa is crowded with important soft structures. It has a rich blood supply from the internal maxillary vessels. The middle meningeal artery enters the cranium by way of the foramen spinosum only 2 mm. lateral to the foramen ovale, and might easily be pinched against the bone and ruptured by the needle point. Ecchymosis and œdema of the cheek and neck is a common occurrence, and cases are met with, in any considerable series of punctures, which develop large disfiguring hæmatomata, a source of annoyance to both patient and operator. The Eustachian tube lies in a groove on the under surface of the skull about 5 mm. posterior to the foramen ovale. Its cartilaginous wall offers a degree of resistance to the needle point which is scarcely distinguishable from that encountered during passage of the foramen; and, particularly where it is the custom to inject a few drops of novocain before introducing alcohol or where the entire procedure is carried out under general anæsthesia, there is danger of infiltrating the middle ear with alcohol. Cushing (1920) reports a case of a woman, who had undergone such an accident and came to him suffering not only with an unrelieved trigeminal neuralgia but with the agony of a middle and internal ear necrosis. She ultimately died of meningitis. So strong a tissue fixative as concentrated alcohol may do much damage not only at the point of injection, but at a distance by spreading along fascial planes. Cushing (1920) has witnessed locking of the temporo-mandibular articulation, sloughing of the nasal bones and fibrosis of the pterygoid muscles with traction of the jaw to one side. As the needle passes into the skull, according to the method of Harris, it is directed toward the internal carotid artery, and a mistake in depth of one or two centimetres means puncture of that vessel. This is highly improbable when the rules of the technic are faithfully observed and under favorable conditions, but the possibility cannot be eliminated and is discomforting, to say the least. Neugebauer (1918) accidentally punctured the internal carotid in this way, with

immediately fatal results. The dangers surrounding infiltration of the ganglion itself with alcohol are discussed below.

A large amount of work has been expended in an effort to overcome the uncertainties and eliminate the dangers of ganglion puncture *via* the foramen ovale, and as a result there has accumulated a most interesting assortment of schemes for this purpose. Resort was first had to the natural bony landmarks of the skull. For instance, it has been pointed out that the external pterygoid plate and the lateral surface of the maxillary tuberosity lie directly anterior to the foramen ovale and may be used as indicators of the depth of the foramen from the cheek. Thus, Braun (1920), in using the Harris approach, recommends that a preliminary puncture be made to ascertain the depth of the pterygoid plate, and with this as a guide a second puncture in quest of the foramen. Offerhaus (1910) employs the maxillary tuberosities for this purpose. He measures inside the mouth the distance separating the tuberosities and subtracts this from the interzygomatic diameter. The remainder divided by two represents the depth of the foramen from the zygoma. Hertzler (1920) has attempted to simplify Härtel's method by employing the following rule: " Locate the parietal eminence (of the opposite side of the head) with the thumb and the external occipital protuberance with the third finger, while the index finger makes a point midway between the two landmarks. The needle enters the cheek opposite the upper second molar and is then passed directly toward the index finger which is located as described above." Attempts have been made to estimate the depth of the foramen ovale from the surface by use of the interzygomatic diameter alone. With observations upon a large number of skulls Patrick (1912) formulated a rule, that when the interzygomatic distance is five inches, the foramen is at a depth of 4.0 to 4.25 cm.; when the interzygomatic distance is five and one-half inches, the foramen is over 4.5 cm. from the surface of the cheek. To the same end Smith and Neil (1920) subtract 1 cm. from the interzygomatic diameter and multiply by nineteen-sixty-fourths. They apply this rule in conjunction with a mechanical needle-director, an instrument based upon geometrical principles calculated to guide the needle through the foramen ovale into the ganglion. The method necessitates a double puncture. Byrnes (1915), too, has invented an instrument somewhat of this nature. Employment of the fluoroscope in ganglion puncture has been suggested by Pollock and Potter (1916). In order that the foramen be readily located on the screen, a lead catheter is passed into the Eustachian tube as a preliminary measure. The method offers considerable promise as a means of directing deep cranial punctures, but at present is of little practical value, for the X-rays are deflected so diversely, in their passage through the bony planes of the skull, as to distort the needle pathway and render its recognition difficult.

In reviewing these carefully conceived inventions and many more which are described in the literature, one cannot help but be impressed with the ardor and ingenuity which have entered into their creation. Surely the pur- ·

pose must be well worth seeking. But any method of approach to the ganglion through the foramen ovale is lacking in two important respects. There is no natural, easily followed pathway leading to the foramen, and there is no limiting boundary to indicate the proper depth of penetration. Could the needle be passed with but a single thrust, and were there certain means of knowing when the needle point has reached its goal, then ganglion puncture would be robbed of a great many of the dangers now attending it. Where neighboring anatomical landmarks have failed to guide the needle adequately, mechanical devices have been employed; but the human body is not built according to the principles of mathematics, and it is folly to attempt to fathom its spatial relations by such means. Patrick (1912) has attempted to express the degree of accuracy attained in his injections. He says: " I have made about 500 deep injections. . . . Of these, for the inferior branch (third division), about 27 per cent. have been misses, 45 per cent. partial successes, and 28 per cent. good." These figures have to do not with individual insertions of the needle, but with sittings; moreover, the object sought was injection of the bifurcating nerve trunk at its exit from the foramen, at all odds a simpler problem than penetration of the foramen. When only one-quarter of his attempts at the third division proves successful, surely an operator with less experience than his could not hope to place a needle in the ganglion itself by this route with as great success.

It is for the purpose of presenting a hitherto untried avenue of needle-approach to the Gasserian ganglion which will satisfy those two primary requirements and at the same time remain within the boundary of reasonable safety, that this paper is written. The approach is the orbit, the path followed is the medial orbital wall, and the portal of entrance to the cranial cavity the sphenoidal fissure. The needle is guided by sense of touch along a smooth bony surface, until its progress is obstructed by the bony fossa lodging the Gasserian ganglion.

ANATOMY

We are concerned with the anatomy of the medial wall of the orbit, the sphenoidal fissure and the middle cranial fossa. (See Figs. 1 to 8.)

The medial wall of the orbit is a smooth, flat surface directed in an antero-posterior plane. Its anterior extremity becomes continuous with the root of the nose, and presents above a small depression for attachment of the pulley of the superior oblique muscle and below a groove occupied by the lachrymal sac. The internal tarsal ligament is attached at a point just below its centre, and marks the upper limit of the lachrymal sac. Between the internal tarsal ligament and the superior oblique pulley the surface of the bone is occupied by no structures of importance. The medial wall of the orbit slopes away into the orbital roof above and into the orbital floor below, and leads posteriorly into two apertures connecting the orbit with the medial cranial fossa, an upper, the optic foramen, for transmission of the optic nerve and ophthalmic artery, and a lower, the sphenoidal fissure, for transmission of the other structures which enter the orbit. The upper margin of the orbital wall is pierced by two foramina for passage
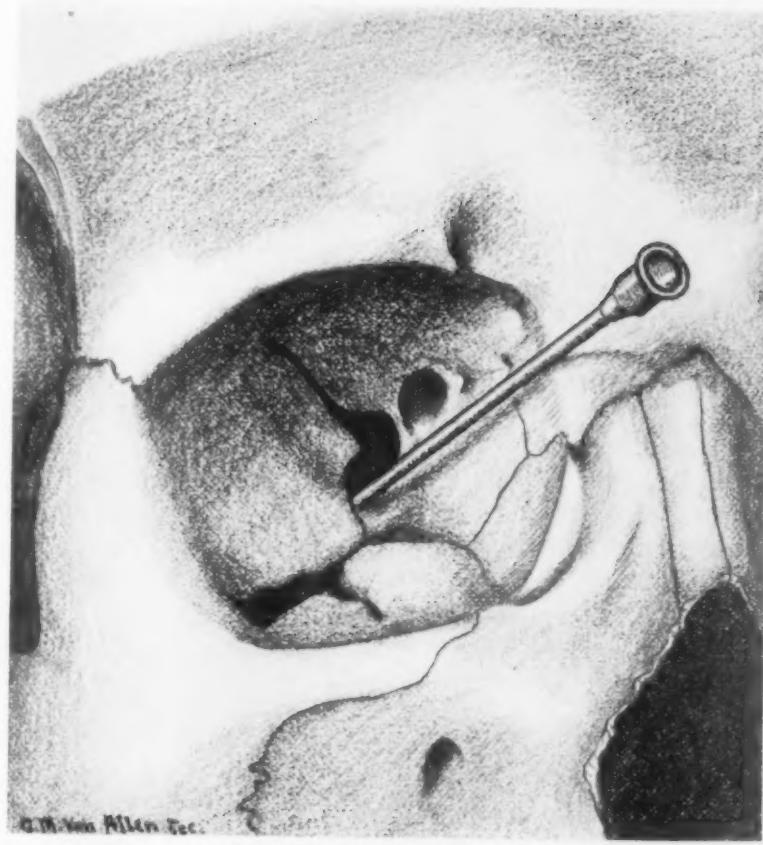
FIG. 1—Anterior view of the right orbit, indicating the first portion of the needle path.
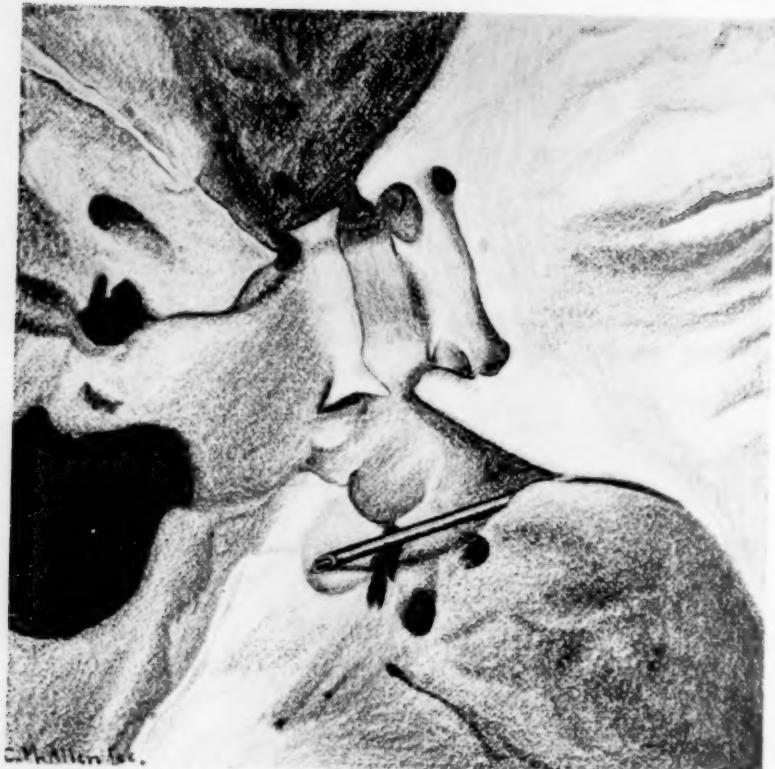
FIG. 2.—Right lateral view of the interior of the skull, indicating the last portion of the needle path in the middle fossa. The needle point lies in the fossa Gasseri.

(a)

(b)

Root of Fourth Nerve

Sella Turcica

Basilar Artery

Root of Sixth Nerve

Root of Fifth Nerve

Foramen Magnum

Roots of Seventh and
Eighth Nerves

Reflected wall of Cavernous Sinus

Internal Carotid Artery in Cavernous Sinus

Third Nerve in Cavernous Sinus

Fourth Nerve in Cavernous Sinus

Ophthalmic Division of the
Fifth Nerve

Needle passing through
Sphenoidal Fissure

Capsule of Gasserian
Ganglion

Maxillary Division of
Fifth Nerve

Gasserian Ganglion con-
tained in Meckel's Cave

Reflected Ganglion Cap-
sule opening Meckel's Cave

Reflected Dura Mater

Mandibular Division of the
Fifth Nerve

(c)

FIG. 3.—a. Same as FIG. 2, with dura mater in place, representing the sub-dural course of the needle through
the middle fossa.
b.   Same as FIG. 3a, representing the transdural course of the needle through the middle fossa.
c.   Same as FIG. 3a, in outline, with the dura mater of the middle fossa reflected, representing the relations
of the Gasserian ganglion and the puncture needle.
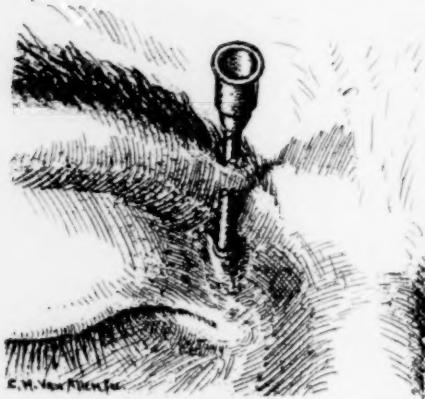
FIG. 4.— a. The author's needle used in puncture of the Gasserian ganglion (greatly enlarged).
b. The right eye, illustrating the first direction taken in inserting the needle.
c. The right eye, illustrating the position of the needle when the ganglion is reached.

of the ethmoidal nerves and vessels. Otherwise its surface is occupied only by loosely applied periosteal lining, over which plays the medial rectus muscle. The medial orbital wall is formed chiefly by the ethmoid, and aids in enclosing the ethmoidal air sinuses.

The sphenoidal fissure is a narrow opening obliquely situated in the back of the orbit and opening through the anterior wall of the middle cranial fossa. Its lower or medial extremity is at the level of the floor of the orbit. The tendon of origin of the lateral rectus muscle is so arranged as to bridge across the sphenoidal fissure and to divide it into two compartments. The upper of these compartments transmits all the structures of the fissure; the lower contains fat and connective tissue only.

The middle fossa of the skull encloses the temporal lobe of the cerebrum. It is bounded anteriorly by the greater and lesser wings of the sphenoid, posteriorly by the petrous portion of the temporal bone, and medially by the body of the sphenoid. On the anterior surface of the petrous portion of the temporal bone there is a shallow excavation, the fossa Gasseri, for lodgment of the Gasserian ganglion. This fossa is so situated that it faces forward and will intercept a straight line drawn along the medial wall of the orbit, commencing at the pulley of the superior oblique muscle and extending through the lower extremity of the sphenoidal fissure. The portion of this line between the sphenoidal fissure and the fossa Gasseri marks the situation of the lateral wall of the cavernous sinus. The sinus wall is composed of dura matter which is separated into two layers by nerve trunks passing forward to the orbit. These nerves are four in number, the oculomotor above, the trochlear next, and below the first and second divisions of the trigeminal. Between this wall and the body of the sphenoid is an interval of about 1.5 cm. occupied by the cavernous sinus, through which run the internal carotid artery and the abducent nerve. (See Fig. 8.)

The trigeminal nerve leaves the pons beneath the tentorium and runs forward over the apex of the petrous bone, pushing a diverticulum of dura with it from the posterior fossa beneath the dura lining the floor of the middle fossa. This diverticulum is known as Meckel's cave. Here the sensory portion of the nerve takes on a ganglionic enlargement (Gasserian ganglion. See Fig. 3c.) The limiting boundary of the cave of Meckel is indicated on the surface of the dissected ganglion as a semicircular line demarcating the root of the ganglion from its body, and giving to it the name of semilunar ganglion. That portion of the trigeminus contained within the cave is made up of loosely grouped fibres and consists for the most part of nerve axons on their way to the brain. The cerebrospinal fluid of the posterior fossa finds ready access to Meckel's cave and bathes the nerve contained within it. The major part of the ganglion is situated under the dura just beyond the limits of the cave, it is of firm texture and encased in a fibrous capsule. The ganglion gives rise to three nerve trunks, the first and second passing forward between the two layers of the wall of the cavernous sinus to enter the sphenoidal fissure and the foramen rotundum, respectively, and the third passing downward to enter the foramen ovale.

With this hasty review of the regional anatomy, we may better understand the pathway taken by the needle. This path is that of the line mentioned above, passing through the orbit, sphenoidal fissure and middle cranial fossa to the Gasserian ganglion. The needle is guided through the orbit by following its medial wall backwards to the sphenoidal fissure. It is separated from the delicate structures of the orbit by the medial rectus muscle; and in the sphenoidal fissure it occupies the lower compartment

which contains no nerves or vessels. These relations are to be seen in Figs. 5 and 6. The direction given the needle in passing through the orbit determines its rout through the middle cranial fossa. Accordingly, as the orbital wall varies in position, so the needle's course beyond it will be made to vary and will pursue any one of four routes. Thus, upon leaving the sphenoidal fissure, it may enter between the two layers of the lateral wall of the cavernous sinus, and travel thus posteriorly into the Gasserian ganglion (Fig. 8, right side); it may take up a more lateral course and traverse the temporal lobe cortex before reaching the ganglion (Fig. 8, left side); it may pass more medially and transfix the cavernous sinus en route to the ganglion; or, finally, it may run so far medially as to terminate within the sinus and never reach the ganglion. By whichever of these routes the needle may pass, it is brought to stop by the petrous portion of the temporal bone, and can go no further.

TECHNIC

The instrument used in this puncture is the Patrick cranial needle, purchasable at any of the standard instrument companies, 10 cm. in length and $1\frac{1}{2}$ mm. in diameter, equipped with a closely fitting stylet. The point is ground back 3 or 4 mm., in order that the stylet may protrude a short distance. Thus, when the stylet is in place, the instrument becomes a blunt-pointed probe; when withdrawn, there remains a sharp-pointed hollow needle. This instrument is illustrated in Fig. 4a.

The patient is placed in a dorsal-recumbent position, and the operator stands at his head. The upper inner angle of the orbit and the medial orbital wall, as far as can be reached with a small hypodermic needle, are infiltrated with 1 per cent. novocain solution. With the finger-tip placed well under the orbital arch, search is made for the pulley of the superior oblique muscle, felt as a small hard knob upon the surface of the bone. A 3 or 4 mm. incision is now made just below this pulley and carried through the skin and fascia to the bone beneath (Fig. 4b). With the knife tip the periosteum leading into the orbit is loosened to a distance of 0.5 cm. Bleeding is controlled by pressure. The needle with the stylet in place is grasped between the thumb and forefingers as in holding a syringe, and its blunt point is inserted within the incision underneath the periosteum against the surface of the bone. Passage is now commenced in a direction backwards and towards the mouth. In this direction the medial wall of the orbit is soon felt to slope away laterally into the floor. Feeling with the blunt needle point and using the upper inner angle of the orbit as a fulcrum, the junction of wall and floor is followed posteriorly through the orbit to a depth of about one-half the needle's length, when a bony obstruction is reached. This obstruction is the lower margin of the sphenoidal fissure, and serves the useful purpose of indicating that the posterior extremity of the orbit has been reached. The needle point is lifted over this margin and passed into the fissure. Now a pause is taken to make sure of two things—first, that the shaft of the needle

is held firmly against the upper inner angle of the orbit, and, second, that the tip of the needle is lodged within the lower extremity of the sphenoidal fissure. These two points establish definitely the further course of the needle. The stylet is withdrawn, and the needle is driven straight through the middle cranial fossa until blocked by bony resistance. By this sign, as well as by complaint on the part of the patient of trigeminal pain, it is known that the Gasserian ganglion is reached, and injection may be made (Fig. 4c).

In making the puncture the following practical points should be emphasized:

Should the preliminary loosening of the periosteum at the margin of the orbit be not extensive enough, some difficulty will be experienced in starting the needle upon its journey, for here the tarsal fascia is firmly attached to the bone. It is better to reinsert the knife and free the periosteum to a further extent, than to force the needle. Once started the needle travels with but little resistance along the medial wall of the orbit. Because of rough manipulation or an unusually thin orbital plate, the needle may break through the medial orbital wall and come to lodge within the ethmoidal air sinus beneath. Such an accident is appreciated by the premature obstruction which it causes, and is remedied by withdrawing the needle a short distance and replacing it in its correct channel. The needle point is made to travel along the line of junction of the medial wall with the floor of the orbit, because thereby it is carried directly to the lower extremity of the sphenoidal fissure and is prevented from wandering upwards onto the medial orbital wall, where it would inflict damage to the ethmoidal vessels, or laterally onto the floor of the orbit where it would encounter the inferior orbital fissure. The lower margin of the sphenoidal fissure varies considerably in prominence. In the great majority of cases it can be easily recognized and easily surmounted; occasionally it cannot be felt, and the only indication of the position of the needle is the added resistance of the tissues occupying the fissure; while at times the margin is so outstanding as to cause difficulty in orientation. However, in any case, it is only necessary to move the needle point cautiously upwards, to discover the lower extremity of the sphenoidal fissure. The orbital portion of the route requires a dull-pointed needle to facilitate palpation, and here, accordingly, the stylet is used; but behind the sphenoidal fissure palpation is no longer necessary and the stylet is discarded, in order that with the sharp point the tough planes of dura in this region may be cut cleanly through. The exact depth of the Gasserian ganglion from the surface by this approach varies considerably (8.5 to 10.0 cm.) and bears little significance in the performance of the puncture, for reliance is placed upon the skull surfaces to guide the needle and to stop it when the ganglion is reached. As regards discomfort caused by the puncture, it can be said that the preliminary novocain infiltration controls the first portion of the route completely, but the moment the fissure is passed the patient complains bitterly of pain referred to the inside of the head (dura) and to the trigeminal field.

This part of the puncture is performed rapidly and the pain is relieved by immediate injection of novocain.

Ganglion puncture by the orbital route involves certain dangers. Rupture of the medial wall of the orbit by the needle point might lead to contamination of the needle, should the underlying sinus be the seat of infection. It is unnecessary to suggest that under such conditions further introduction of the needle should be abandoned. In over half of the cases it has been demonstrated that the needle traverses the cavernous sinus on its way to the ganglion. It might be expected that such injury to the wall of the sinus would lead to hemorrhage within the skull. However, one cannot compare the great venous spaces of the dura to veins elsewhere in the body, for the skull is a rigid box with an internal tension produced by the rise and fall of arterial pressure. The venous blood returns at a pressure well below this. Accordingly, under conditions of maintained intracranial tension there could be no extravasation of blood from an injured sinus wall into the surrounding medium. Invasion of the cavernous sinus might result in thrombosis. But such a thrombosis would be aseptic, and except for temporary disturbance of circulation in regions drained by the sinus and the possibility of pulmonary embolism, it is difficult to conceive of injurious consequences. Sometimes the needle's path lies through the temporal lobe cortex, but this is a so-called silent region of the brain, and no ill effects need be expected. In a small percentage of cases the needle does not reach the ganglion, but terminates within the cavernous sinus. This fact can be recognized immediately upon removal of the stylet, for venous blood flows slowly from the needle. When this occurs, of course, injection of alcohol is contraindicated. The internal carotid artery lies 0.5 to 1.0 cm. medial to the sphenoidal fissure and is thus effectually sheltered from injury in all cases, except where, because of aneurismic dilatation, it may occupy an abnormal position. The needle is guided to its destination by the natural bony planes of the skull. Failure to reach the ganglion is due to unusual variation of these planes and cannot be remedied by meddlesome probing. The needle can do no harm in its prescribed channel, but it does not have to wander far afield to inflict serious damage. A good rule to adhere to in the use of this puncture is never to make a second attempt, when the first properly applied is unsuccessful.

LABORATORY INVESTIGATION

Anatomical study of this method of Gasserian ganglion puncture has been carried out as follows:

Upon twenty-four cadavers available in the dissecting rooms of the Department of Anatomy, Yale School of Medicine, bilateral Gasserian punctures and injections with methylene blue were performed. After each injection a strand of wire was inserted in the needle bore and allowed to remain as an indicator of the pathway followed. Careful dissections were then made in each case to study this pathway and to determine the behavior of the injected fluid. The results of this investigation are summarized thus:

Material ....25 cadavers {
White, 23 {
Male, 21
Female, 1
}
Colored, 2
}

Number of punctures performed......50 {
Successful, 41
Unsuccessful, 9 {
Adult male, 5
eight-year female, 2
microcephalus, 2
}
}

Pathway taken by the needle........... {
Through sphenoidal fissure, 47
Through foramen rotundum, 2
Cranium not entered, 1
}

Depth of sphenoidal fissure from the nasal bridge .... {
Maximum depth, 7.2 cm.
Minimum depth, 5.0 cm.
Depth of greatest frequency, 6.8 cm.
}

Depth of Gasserian fossa.............. {
Maximum depth, 10.0 cm.
Minimum depth, 8.5 cm.
Depth of greatest frequency, 9.3 cm.
}

Trauma to medial orbital wall.......... {
Broken through, 6
(all of which occurred among the first 15)
Crackling of the bone felt, 11
No injury, 33
}

Recognition of inferior margin of sphenoidal fissure .... {
Margin felt, 40
Margin not felt, 9
}

Passage of needle in relation to dura mater .... {
Beneath dura, 39
Dura punctured, 10
(of which 8 occurred among the first 9)
}

Passage of needle in relation to cavernous sinus .... {
Sinus entered, 14
Sinus not entered, 35
}

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Difficulty encountered in passage of needle ....
- Easy passage, 39
- Slightly difficult, 10
- Passage impossible, 1

Nature of fluid injected ....
- Alcoholic solution of methylene blue, 23
- Aqueous solution of methylene blue, 27

Behavior of fluid injected..............
- Complete infiltration of the ganglion, 38
- Partial infiltration of the ganglion, 3
- Infiltration into the cavernous sinus, 4
- No fluid injected, 5

Upon a well-preserved human head bilateral Gasserian puncture by the orbital route was carried out, and, instead of wire, broom-straws were left to occupy the needle path. The specimen was then frozen and sawed in serial sections taken in a frontal plane. By study of these sections, each with its fragments of broom-straw *in situ,* an exact determination of the position of the needle was obtainable at intervals of 0.5 to 1.0 cm. throughout its course from the skin to the ganglion. Outline tracings of these sections are reproduced in Figs. 5, 6, 7 and 8. It so happened that in this specimen the needle on each side followed a different pathway in the middle cranial fossa. On the right side the needle passed between the layers of the wall of the cavernous sinus; and on the left side through the temporal lobe cortex. These are two of the four ways that may be taken, as have been pointed out above.

Of particular interest in this experimental work was the behavior of the injected stain. In the great majority of cases the needle entered the root of the ganglion contained in Meckel's cave, and the first two or three drops of fluid injected filled the cave and saturated the nerve in it. The body of the ganglion lying outside of the cave was free from stain, as well as other structures in the neighborhood. In the remaining successful punctures the needle lodged in some part of the ganglion itself. Fluid deposited here had no opportunity to spread throughout the ganglion but almost immediately followed the path of least resistance upwards into the cave of Meckel, where it saturated the nerve root. In other words, the procedure is primarily an injection of the ganglion root. Every fibre of the nerve passes through the cave and is involved. There is a feature which needs emphasis and careful consideration This is the fact that Meckel's cave can hold only a few drops of fluid and any excess flows freely backwards along the nerve trunk into the subarachnoid cistern at the base of the brain. Such an event is inevitable when fluid is injected into the Gasserian ganglion by any method in quantity greater than 0.5 c.c. Many instances are on record of ganglion puncture by technics of Harris and Härtel, which presented undoubted

Surface Section
Indicating Points of Needle Entrance

Section through Frontal Sinuses

1.1 cm. Depth

FIG. 5.—Tracings of the first two of a series of frozen sections taken in a frontal plane throughout the pathway of the needle. The rest of the series are represented in Figs. 6, 7 and 8, arranged in a ventro-dorsal sequence. Solid dots indicate the position of the needle in each section.

Levat. Palp. Sup. M.
Sup. Oblique Tend.
Infratrochlear N.
Lacrimal Gland
Needle Path
Int. Rectus M.

Superior Oblique M.
Its reflected Tendon
Infratrochlear N.
Needle Path
Ethmoidal Sinus
Eye ball
Medial Orbit Wall
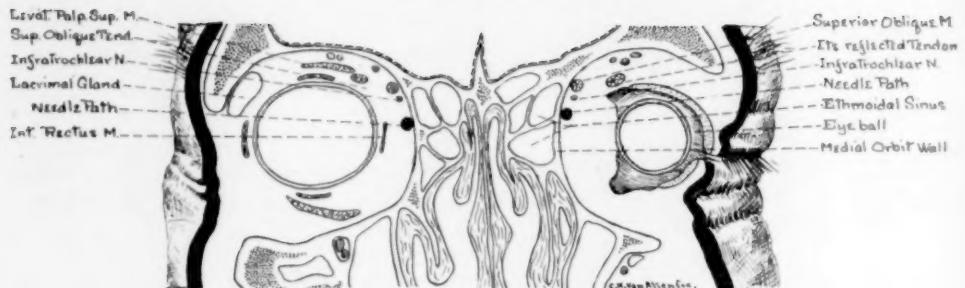
Section through Anterior Orbits

2.1 cm. Depth

Nasal Artery
Superior Oblique Muscle
Ethmoidal Sinus
Needle Path
Eyeball

Levator Palpebrae M.
Superior Rectus Muscle
Nasal Nerve
Lacrimal Gland
Needle Path
Internal Rectus Muscle

Section through Middle Orbits

2.9 cm. Depth

Supra-trochlear Nerve
Nasal Nerve
Optic Nerve
Internal Rectus Muscle
Needle Path
Ethmoidal Sinus
Inferior Rectus Muscle

Supra-orbital Nerve
Superior Rectus Muscle
Superior Oblique Muscle
Internal Rectus Muscle
Optic N. + Eye ball
Needle Path

Section through Posterior Orbits

3.4 cm. Depth

FIG. 6.—Tracings of the third, fourth and fifth of the series of frozen sections.

Superior Rectus Muscle
Internal Rectus Muscle
Optic Nerve
Nasal Nerve
External Rectus Muscle
Inferior Rectus Muscle
Needle Path

Anterior Cranial Fossa
Superior Oblique Muscle
Internal Rectus Muscle
Nasal Artery
Optic Nerve
Needle Path
External Rectus Muscle
Ethmoidal Sinuses

Section through Posterior Orbits
4.8 cm. Depth

Anterior Clinoid Process
Ophthalmic Div. of Vth N.
Oculo-motor Nerve
Trochlear Nerve
Ophthalmic Artery
Ophthalmic Vein
Inferior Rectus Muscle
Needle Path

Maxillary Div. of Vth N.

Middle Cranial Fossa
Superior Rectus Muscle
Optic Nerve
Ophthalmic Artery
External Rectus Muscle
Inferior Rectus Muscle
Sphenoidal Sinus
Needle Path

Maxillary Div. of Vth N.

Section through Sphenoidal Fissures
5.9 cm. Depth

Supra-orbital Nerve
Sphenoidal Fissure
Superior Rectus Muscle
Lacrimal Nerve
Oculo-motor Nerve
Naso-ciliary Nerve
Abducent Nerve
External Rectus Muscle
Sphenoidal Fissure
Needle

Levator Palpebrae Muscle
Trochlear Nerve
Superior Oblique Muscle
Optic Nerve
Optic Foramen
Internal Rectus Muscle
Ophthalmic Artery
Ophthalmic Vein
Inferior Rectus Muscle
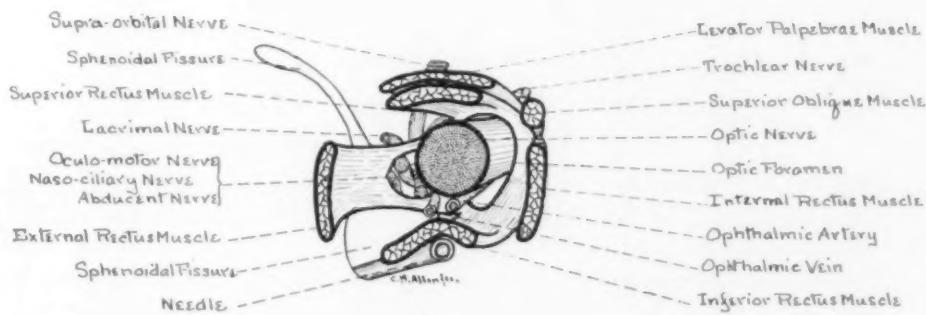
Diagram in Perspective Illustrating Needle Passage through
Posterior Orbit and Sphenoidal Fissure (Right)

FIG. 7.—Tracings of the sixth and seventh of the series of frozen sections.
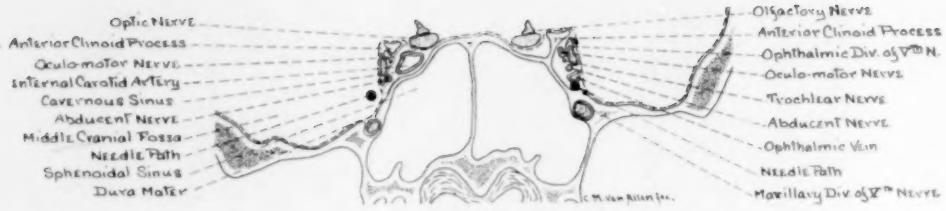
Section through Cavernous Sinuses Anteriorly

6.6 cm. Depth
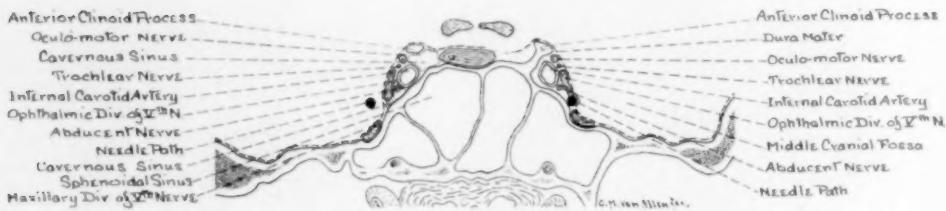
Section through Cavernous Sinuses Anteriorly

7.4 cm. Depth
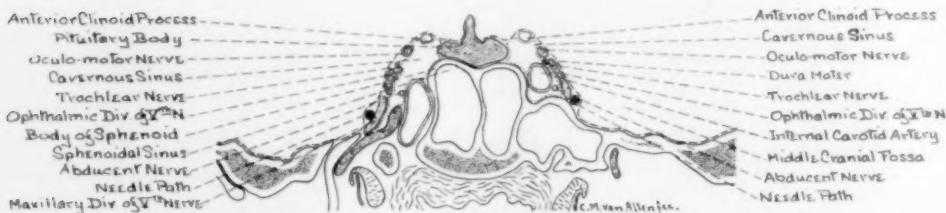
Section through Middle of Cavernous Sinuses

8.0 cm. Depth
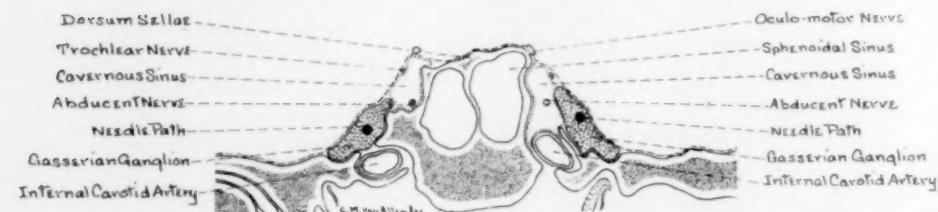
Section through Cavernous Sinuses and Gasserian Ganglions

8.6 cm. Depth

FIG. 8.—Tracings of the eighth, ninth, tenth and eleventh of the series of frozen sections.

symptoms of irritation of the structures in the basilar cistern, principally of the third, fourth, sixth, seventh and eighth cranial nerves. This liability offers the one serious objection to alcoholization of the Gasserian ganglion.

To sum up the results of cadaver experimentation—of fifty-two consecutive punctures, forty-three have been shown to enter and successfully infiltrate the ganglion root. Of the remaining nine, two upon a microcephalus and two upon a child of eight years may be eliminated, for they did not have to do with normal adult skulls. Five punctures were failures—four because the needle terminated within the cavernous sinus, and one because for some unascertained reason the sphenoidal fissure could not be found. We may conclude, then, that from an anatomical standpoint the technic shows an efficiency of about 90 per cent.

Attempt has been made to investigate the physiological effects of the puncture by experiment upon lower animals. The regional anatomy of the dog, rabbit and monkey were studied with the hope that an animal could be found which would present conditions comparable to those found in men. Puncture of the ganglion was carried out in the dog, but in order to enter the sphenoidal fissure at a proper angle the needle had to pass directly through the orbital fat, and so much hemorrhage resulted that no valuable conclusion could be drawn, and the attempt was abandoned. The monkey gave better promise, for its orbit is almost identical with that of man. Accordingly a Macacus monkey was secured and operated upon with the aid of general anæsthesia. The result of the puncture was almost instant death. Autopsy showed that on both sides the needle had entered the internal carotid artery. Possibly some other species of monkey would be better adapted to the experiment, but further investigation of this nature offered little of value.

CLINICAL APPLICATION

Without adequate proof of the innocuousness of the puncture, it was felt that an application to the living subject in the clinic could be justified only in those cases where no less hazardous means is known of preventing a fatal outcome of disease. Such circumstances are often found in malignant disease of the face. These patients are usually aged and infirm and very poor subjects for general anæsthesia. The tumor is frequently too deeply seated to allow of local infiltration anæsthesia; ganglion block alone can accomplish the purpose. We have applied the method first of all in just such extreme cases.

CASE REPORTS

CASE I.—The patient, a white female, ninety-four years of age, came for treatment January 14, 1921, suffering from basal-cell epithelioma of the superior orbital margin. The tumor was of three months' duration. It had invaded the orbit and was giving increasing pain. The extreme senility of the patient forbade the use of general anæsthesia, and the situation of the tumor ruled out the use of local infiltration. January 16, 1921, by the aid of 1 per cent. novocain infiltration of the inner angle of the orbit, a transorbital puncture was carried out and the Gasserian ganglion injected with a few drops of 5 per cent. cocain solution.

There developed almost immediately a complete anæsthesia of the trigeminal field on that side, and under its influence the tumor was excised, together with the underlying periosteum and the eyelid. The defect was covered by skin flaps taken from the scalp, the incision extending upwards almost as far as the coronal suture. The patient suffered not the least discomfort from operative manipulations. Except for mild nausea and vomiting occurring at the close of operation and referable to the cocain, there were no constitutional disturbances and but little shock. The wound healed rapidly and recovery was without incident.

CASE II.—The patient, a white male, sixty years of age, came under observation March 19, 1921, with a rodent ulcer of the cheek; four months' duration. One X-ray and seven radium treatments had produced no effect. Examination showed an indurated ulcer of the right cheek extending from the angle of the mouth to the masseter muscle. It had perforated into the mouth at two places, and involved the alveolar processes of both upper and lower jaws (Fig. 9). No metastasis was made out. At operation, March 21st, the needle was passed through the orbit into the ganglion. Upon removing the stylet spinal fluid exuded from the needle. One and five-tenths c.c. of 4 per cent. novocain solution was slowly injected. The needle was left in place. The external carotid artery was ligated under local anæsthesia to control hemorrhage. Then operation upon the face was carried out in the following steps: Thorough cauterization of the ulcer margins; division of the lower lip, chin and symphysis in the median line; division of the mandibular ramus; partial resection of the superior maxilla; and, finally, removal in a single specimen of the entire ulcerated mass, together with the body of the mandible and a portion of the alveolar process and body of the maxilla. This left a gaping defect in the side of the face. The buccal cavity was then closed off by suture of the mucous membrane of the side of the tongue to that of the hard palate. The wound was left open to allow of free drainage and control of infection in preparation for grafting at a future date. The anæsthetic effect of ganglion block began to wear off twenty-five minutes after the injection, and an additional 2 c.c. of 4 per cent. novocain were required. Except for the region of the midline, which receives partial supply from the opposite trigeminal nerve, and the angle of the jaw, supplied by the cervical plexus, the field of operation was insensitive. Recovery to date has been uneventful. A röntgenogram, taken directly after the operation with the needle still in place, is reproduced in Fig. 10. (This photograph has been retouched and serves only as a diagram to indicate the position of the needle within the skull.)

CASE III.—The patient, a white male, age seventy-nine years, was admitted to the surgical service of the New Haven Hospital February 3, 1921, for treatment of a basal-cell epithelioma of the lower lip, duration two months. In addition he had been a sufferer from attacks of angina pectoris for a number of years, and he presented signs of active pulmonary tuberculosis, of aortic aneurism and of advanced arteriosclerosis. Blood: Wassermann, 4-plus; blood-pressure, 185/110. A preliminary resection of the submental glands was done under local infiltration anæsthesia, March 1st; and four weeks later, March 31st, a portion of the lower lip containing the tumor was excised and the defect closed by plastic operation under the influence of Gasserian ganglion block. The needle was introduced through the orbit in the usual fashion. Upon withdrawal of the stylet spinal fluid flowed from the needle. Two c.c. of 2 per cent. novocain solution were injected. It was found that this strength of novocain produced a profound anæsthesia of the nerve but only of from three to five minutes' duration. Consequently the needle was left in place and small injections were made from time to time (one- to two-minute intervals) throughout the opera-
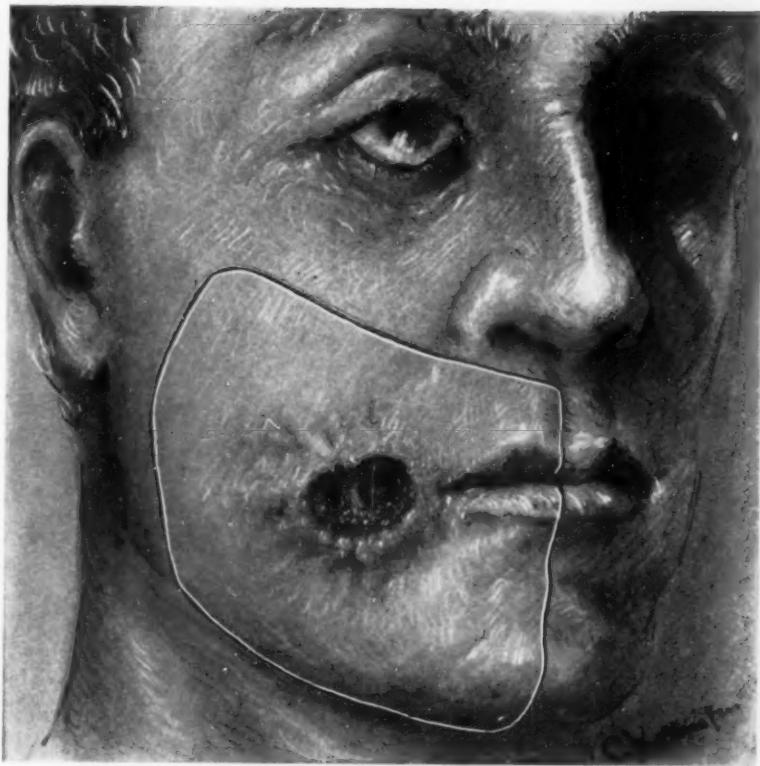
FIG. 9.—Case II. Sketch illustrating the lesion and the outlines of the specimen removed at operation.

FIG. 10.—Case II. Röntgenogram, lateral view of the skull with the needle in place.

FIG. 11.—Case V. Photograph taken three days after alcohol injection for trigeminal neuralgia. The pencilled line indicates the boundary of the anæsthetic zone produced by the injection.

tion. In all, approximately 20 c.c. of 2 per cent. novocain was used. Absolutely no ill effects were experienced either during the operation or upon return to the ward. Recovery presented no complications.

CASE IV.—The patient, a white male, seventy-one years of age, had suffered with severe paroxysms of pain in the second and third divisions of the left trigeminal nerve for six years. During this time he had received seven injections into the branches of the nerve at the base of the skull. The first treatment gave him relief for nearly a year. Each repeated injection was less effective, and the last two produced no result whatever. When he was first seen the paroxysms were occurring at intervals of about three minutes. The patient presented the picture of uniform senile degeneration without grave constitutional defect. On April 21, 1921, transorbital puncture was done. The needle entered without the slightest difficulty and was guided into position in a perfectly normal fashion. When the stylet was removed a stream of blood flowed slowly from the needle. A few drops of novocain were injected, but no anæsthesia resulted and the needle was immediately withdrawn. There were no ill effects from the puncture. Three days later the Gasserian ganglion was removed by open operation. At this time a search was made for any signs of hemorrhage following the puncture of the cavernous sinus, but no evidences were visible in the field of operation.

CASE V.—The patient, a white female, sixty-four years of age, came under observation May 3, 1921, suffering with neuralgia of the third division of the left trigeminal nerve, six years' duration. Paroxysms occurred at intervals of from one to two hours, and lasted ten or fifteen minutes. They were excited by any disturbance of the lower jaw, as in chewing or talking. The mouth had not been cleansed for years for fear of the terrible pain such an act would cause. She had received palliative treatment without benefit. May 4, 1921, a transorbital puncture was carried out. Spinal fluid escaped freely from the needle, and was allowed to flow to the extent of 15 or 20 c.c. Five-tenths c.c. of 4 per cent. novocain solution was injected for the purpose of testing the accuracy of the puncture, and in a few minutes there resulted an anæsthesia of all three divisions. Then 1 c.c. of absolute alcohol was slowly injected. The patient responded immediately by vomiting. The pulse was of good volume and rate, and there was nothing to cause alarm. About ten minutes after the first injection 1 c.c. of alcohol was added; and again in ten or fifteen minutes 0.5 c.c. was injected, making in all 2.5 c.c. of absolute alchohol. Each injection was followed by vomiting, and for a period of one-half hour after removal of the patient to the ward there was distressing nausea. No further constitutional disturbance was noted. As an immediate result of the injection the eyeball on that side was rendered completely immobile, the pupil two-thirds dilated and the eyelid ptosed. One hour later it was noticed that the movements of the eye were gradually returning and the pupil was nearer its normal size. At this time there was evidence of an orbital œdema, which in six hours developed sufficiently to close the lids. There developed, too, a moderate local ecchymosis. Upon discharge from the hospital five days after operation there was no return of the tic, the entire left trigeminal field was anæsthetic and there was a residual paralysis of the superior rectus and levator palpebræ superioris muscles. The œdema was subsiding. On the ninth day the patient was seen again and it appeared that the neuralgic pain had returned in full force. However, the symptoms were either psychic or totally misrepresented, for at repeated examinations, the last ten weeks after injection, the patient complained of nothing other than tingling and smarting sensations at the margins of the anæsthetic zone. This zone was as extensive and insensitive as that obtained at first. The oculomotor paresis had disappeared, and there was no evidence of serious trophic disturbance of the

cornea. A complete left facial paralysis made its appearance during the second week. Very fortunately this was not of a permanent nature, for in a few days it showed signs of clearing, and at the last examination activity had returned to the majority of the facial muscles. Strange to say the eighth nerve has not been impaired. The photograph, Fig. 11, was taken of the patient on May 7th. The boundary of the anæsthetic area is indicated by a line drawn upon the patient's skin. This area extends to the vertex of the head and internally to include the left half of the anterior two-thirds of the tongue, the left half of the palate and the left nasal fossa. It corresponds within the limits of anatomical variation with the field of anæsthesia which has been shown to follow gasserectomy in Cushing's (1904) review of his first twenty-six cases.

In these five cases, three males and two females, the ages varied between sixty and ninety years. The right side was punctured twice and the left three times. The needle was introduced without the slightest difficulty in recognition of the pathway, and was halted at the proper depth by the petrous portion of the temporal bone. In four cases the technic was successful in producing anæsthesia of the entire trigeminal field. In one case (Case IV) the needle failed to reach the ganglion, and only one cause can be ascribed, *i.e.*, some slight variation in the bony contour of the skull. Whether successful or not, the passage of the needle in these instances inflicted no serious damage to the patient. The orbital portion of the route was entirely painless; the passage behind the orbit intensely painful. In two of the cases it was demonstrated by suction on the needle during its entrance that the cavernous sinus was transfixed; in two cases no effort was made to determine whether or not the sinus was injured; and in one it was self-evident that the needle had terminated within the sinus. Yet in no instance were there symptoms to indicate intracranial or retrobulbar hemorrhage. The subcutaneous ecchymosis that followed the puncture in three cases was of no greater extent than could be attributed to any such traumation to these tissues; and the orbital œdema in Case V was very probably induced by a few drops of alcohol left in the orbit by the retiring needle, a complication preventable by negative pressure exerted upon the needle during its withdrawal. In three cases when the bony terminus was reached and the stylet removed, cerebrospinal fluid flowed from the needle; venous blood exuded in one case; and in one the puncture was dry.

To strike cerebrospinal fluid at the end of the passage indicates that the cave of Meckel is reached and that injection of solution will involve the ganglion root; to strike blood indicates clearly that the needle has stopped within the cavernous sinus and that further attempt to reach the ganglion should be abandoned; to obtain a dry puncture means that the needle has entered the lower part of the ganglion below Meckel's cave, and an injection of solution will flow upwards into the cave and thereby infiltrate the nerve root, or that the needle missed its mark and has come to lodge in some non-vascular tissue. An easily executed passage is no certain indication of a successful puncture, nor is complaint on the part of the patient of pain in the trigeminal distribution. A needle terminating near to the nerve may press upon it and

lead to the conclusion that the structure has been entered.   Trial injection of novocain is the most accurate determining factor.

The purpose of the procedure in Cases I, II and III was temporary ganglion block anæsthesia.   In Case I, 5 per cent. cocain solution was used and satisfactory anæsthesia obtained during the entire operation.   This drug, however, was probably responsible for the subsequent vomiting and its use has been given up.   In the second, 4 per cent. novocain solution was employed, 3.5 c.c. in two injections.   The anæsthesia was complete but began to disappear in from fifteen to twenty minutes after the first injection.   In the third case 2 per cent. novocain was used.   Its effects were adequate but very transient, and frequent reinjections were necessary, the total amount of solution used being 20 c.c.   There is little doubt that this novocain solution, far too great in amount to be accommodated by Meckel's cave, flowed back into the basilar cistern at the base of the brain, and yet there was not the slightest sign of its action upon the nerve structures of this region. Evidently the gradual introduction of comparatively large quantities (up to 20 c.c.) of 2 per cent. novocain produces no ill effects, still it is a needless and troublesome performance.   The higher concentration of novocain (4 per cent.) should be employed.

In Case V, the purpose of the puncture was permanent anæsthetization of the trigeminal nerve for the treatment of tic douloureux.   The needle reached the ganglion, and 2.5 c.c. of absolute alcohol were injected in three portions over a period of twenty minutes.   The symptoms which followed this treatment give a clue to the behavior of the injected alcohol.   Because the needle was stopped at a proper depth and gave vent freely to cerebrospinal fluid, and because trial novocain injection produced complete trigeminal anæsthesia, it may be concluded that the needle point had terminated in the perineural space of Meckel's cave.

We have found in our experience with the injection of stain in cadavers, that fluid placed in Meckel's cave, be it more than a few drops in amount, will discharge posteriorly into the basilar cistern.   The cave is apparently in free communication with the subarachnoid spaces at the base of the brain. Alcohol injected in this Case V probably took the same course, and as it entered the cistern was caught in the cerebrospinal stream and dispersed among the cranial nerves which cross the cistern in their passage from the brain stem.   As evidence we have the ophthalmoplegia and facial paralysis following the injection.   It is to be surmised that the alcohol, already somewhat diluted by mixture in the cave, became further diluted in the fluid of the cistern before it attacked the neighboring nerves.   This explains the transiency of the paralysis of the third, fourth, sixth and seventh nerves.

CONCLUSION

It is evident that whatever injury is inflicted upon the root of the ganglion by the injection of alcohol will be shared to a less extent by neighboring nerves.   This is true, no matter by what approach or technic the needle

is entered, and trans-orbital puncture is no exception. Accordingly, until some means shall have been discovered of preventing this widespread diffusion of the alcohol, we cannot at all recommend the puncture in the therapy of trigeminal neuralgia.

Other possibilities for the employment of the technic suggest themselves. It affords a method of withdrawing cerebrospinal fluid directly from the basilar cistern. Wider experience may justify an attempt to use this route for therapeutic applications to the central nervous system. The effect of air injections in the X-ray diagnosis of intracranial disorders is likewise worthy of investigation.

But in the meanwhile the results of this work, both anatomical and clinical, lead us to believe that transorbital puncture of the Gasserian ganglion furnishes a relatively simple means of securing block anæsthesia for operations in the territory supplied by the trigeminus, fully justified in cases where general anæsthesia is contraindicated.

I wish to acknowledge my obligation to Professors Ferris, Burr and Flint for their direction in the investigation of this technic from an anatomical and surgical standpoint; and to Professor Verdi, from whose private practice Cases I, II, IV and V are taken, and to whose encouragement a great deal is owed in the success of these first applications of the technic in the clinic.

BIBLIOGRAPHY

Bartholow, R.: 1874. Cited by Hecht (1907).
Billroth, T., and Neuber, G.: 1884. Cited by Hecht (1907).
Braun, H: Cited by Smith (1920).
Byrnes, C. M.: Bull. Johns Hopkins Hosp., 1915, vol. xxvi, p. 1. 1909. Cited by Byrnes (1916).
Camp, C. D.: Med. Rec., 1914, vol. lxxxv, p. 1116.
Chollin: 1907. Cited by Byrnes (1916).
Cushing, H.: Bull. Johns Hopkins Hosp., 1904, vol. xv, p. 213. J. A. M. A., 1920, vol. lxxv, p. 441.
Dorrance, G. M.: Cited by Pollock and Potter (1916).
Eulenburg, A.: Berl. klin. Wchnschr., 1884, vol. xxi, p. 99.
Grinker, J.: J. A. M. A., 1913, vol. lx, p. 1354.
Harris, W.: Lancet, 1909, vol. i, p. 1310. Lancet, 1912, vol. i, p. 218. Proc. Roy. Soc. Med., 1912, vol. v, p. 115. Brit. Med. Jour., 1920, vol. i, p. 693.
Härtel F.: Arch. f. klin. Chir., 1912, vol. c, p. 193. Deutsch. Ztschr. f. Chir., 1913, vol. cxxxvi, p. 429. Med. Klin., 1914, vol. x, p. 582. Deutsch. med. Wchnschr., 1920, vol. xx, p. 517.
Hauck, S.: St. Louis Med. Rev., 1906, vol. liv, p. 505.
Hecht, D.: J. A. M. A., 1907, vol. lix, p. 1574.
Hertzler, A. E.: Cited by Smith (1920).
Levy, F., and Baudouin, A.: Presse Med., 1906, vol. i, p. 108.
Martin, H. H.: J. A. M. A., 1918, vol. lxxii, p. 1970.
Maes, U.: New Orleans M. and S. J., 1913, vol. lxvi, p. 183.
Neugebauer, F.: Zentralbl. f. Chir., 1918, vol. xxxxv, p. 565.
Offerhaus, H. K.: Lancet, 1906, vol. lxxxxii, p. 47.
Ostwalt, F.: Lancet, 1906, vol. i, p. 1605.
Patrick, H. T.: J. A. M. A., 1912, vol. lviii, p. 155. Cited by Pollock and Potter (1916).

Pollock, L. J., and Potter, H. E.: J. A. M. A., 1916, vol. lxvii, p. 1357.

Pussep, L. M.: Arch. f. Pschiat., 1911, vol. xxxxviii, p. 691.

Rayner, H. H.: Brit. J. Surg., 1919, vol. vii, p. 516.

Rynd: 1840. Cited by Smith (1920).

Schapiro, B. M.: St. Petersb. med. Wchnschr., 1885, vol. ii, p. 219.

Schlösser: Ztschr. f. Augenh., 1903, vol. x, p. 335. Berl. klin. Wchnschr., 1906, vol. xxxxiii, p. 82. Verhandl. d. Kong. f. innere Med., 1907, vol. xxiv, p. 49.

Smith, A. E.: "Block Anæsthesia and Allied Subjects," 1920, C. V. Mosby Co., St. Louis.

Taptas, N.: Presse Med., 1911, vol. lxxx, p. 198.

Vaughan, G. T.: Tr. Am. Surg. A., 1917, vol. xxxv, p. 533.

Wright, G. A.: Lancet, 1907, vol. i, p. 1603.

A STUDY OF METHODS OF PROCEDURE IN RESECTION OF THE ŒSOPHAGUS

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The surgery of the œsophagus for many years has taxed the ingenuity of surgeons all over the world, and although much experimental work has been done since 1871 when Billroth reported the first successful resection, to-day the œsophagus is almost *noli me tangere,* and resection is an operation fraught with many dangers and attempted only in the most desperate cases.

Experimental work and cases have been reported by Billroth, Garré, Van Hacker,[5] Czerny, Stieda, Mallener and others in Germany, Lapèyre and Vulliet in France, and Lilienthal, Myer,[6] Janeway and Green[7] in America, but with all these observers no uniformly successful method of resection has been obtained, although important strides have been made as the result of their efforts.

The surgery of the œsophagus is difficult first from the standpoint of locality, second because of its structure. In its cervical portion it is easily mobilized, but in its thoracic portion it lies deep in the mediastinum in juxta-position to such delicate and important structures as the pericardium, trachea, pleura, vagi, left recurrent laryngeal and sympathetic nerves, thoracic duct, aorta and left subclavian artery and azygos vein. Mobilization is therefore extremely difficult. From the standpoint of microscopic anatomy, it is seen that there is no definite coat sufficiently strong to hold the sutures in place, such as the submucous layer in the intestine, the importance of which Doctor Halsted has demonstrated in intestinal suture. This makes it difficult to procure a line of suture which will withstand tension, and since the œsophagus is fixed at its upper and lower end, each descent of the diaphragm with inspiration causes a strain to be put on the line of union and makes leakage more probable.

Other facts which add to the difficulty and danger of œsophageal resection are (*a*) the inability to stretch the œsophagus and thus approximate the two ends after excision of a portion, (*b*) the absence of a serous coat which results in the failure of adhesions, which would prevent leakage, to form around the line of union, (*c*) the low resistance of the loose connective tissue of the mediastinum to infection, and (*d*) the constant presence of bacteria in the œsophageal lumen.

The first successful report of resection was made by Billroth[1] in 1871. He excised a segment of the cervical portion of the œsophagus, making a fistula in the neck, through which bougies were passed to prevent stricture and through which the patient was fed.

Czerny, in 1895, reported a case in which he resected 4 cm. of the œsophagus 17 cm. below the teeth. Approximation of the ends was not possible,

so he put in four fixation sutures and inserted a tube from the mouth through the upper segment and down into the lower segment. The wound was closed and the tube remained in four days. The patient recovered. Garré [3] reported a similar case in 1898, and a year later another case which he did in two stages. First, he did a gastrostomy to improve the general condition of the patient, and in a second operation he resected 9 cm. of the œsophagus for carcinoma 16 cm. below the incisor teeth. He buried the lower end of the upper segment in the wall of the thorax, closed the upper end of the lower segment, and fed the patient through the gastrostomy opening. The patient was well at the end of one year. In the same year Sandelin reported a case in which he closed the œsophagus layer to layer after resecting a stricture in the cervical portion. He inserted a tube to protect the sutures past the line of anastomosis and the patient recovered. Similar successful cases have been reported by Narath and Braun, in which the ends of the œsophagus after resection were closed layer to layer and a tube inserted to protect the sutures.

It is therefore seen that up until comparatively recently resection of the œsophagus has been attempted, at least in humans, only in its cervical portion. With the advance of the surgery of the thorax and the introduction of various positive pressure apparatuses, surgeons have beeen able to attack the problems of œsophago-gastrostomy and resection of the thoracic œsophagus. It was soon realized that, because of the numerous difficulties mentioned at the beginning of this article, a plastic operation was the procedure of choice in cases of resection. This led Bircher,[4] in 1894, to attempt the construction of a skin tube which was united to the œsophagus in the neck and to the stomach at a gastrostomy opening. The patient died of pulmonary embolism shortly after operation.

Wullstein,[8] in 1904, realizing the difficulty of anastomosing the stomach and the skin tube because the acid gastric juice may cause the line of anastomosis to break down, advised shunting off the stomach and duodenum and connecting the skin tube to the jejunum. This method met with no success, but in 1907 Roux isolated a loop of jejunum, drew it up as far as the sternal notch by tunneling under the skin of the thorax, and anastomosed it with the cervical œsophagus above, and the stomach below. This was tried in several cases, in all of which the isolated jejunal loop became gangrenous as a result of disturbance in its blood supply. This led Herzen,[9] in 1908, to bring the jejunum through a slit in the transverse mesocolon and gastrocolic ligament in order to avoid twisting the mesentery which causes constriction of its vessels and results in necrosis of the jejunum. The patient recovered. These observations caused Lexer,[11] in 1911, in a case of carcinoma of the œsophagus to do a combination of the Roux and Wullstein methods. At the first operation he performed a Y-shaped anastomosis of the stomach and jejunum. At a second operation he created a skin tube, did an œsophagostomy and united the skin tube with the upper end of the œsophagus and the jejunum. The patient recovered.

Stieda,[16] 1913, in a case of impermeable stricture following erosion of the œsophagus due to swallowing H_2SO_4, carried out the following procedure with success: First operation—gastrostomy. Six months later he constructed a skin tube by making two incisions 3 cm. apart, parallel to the sternum and slightly to the left of the midline. These began at the level of the left clavicle and extended to the xiphoid. The edges of this strip were then dissected up just a little and then sewed together, forming a tube. There resulted, of course, an area, where the skin flaps had been taken, not covered by skin. This was remedied by mobilizing the outer edges of the defect and sewing them together over the skin tube, thus covering the defect and the tube with skin. The lumen of this skin tube was maintained by the daily passage of bougies. This method of instrumentation is preferable to the insertion of an indwelling rubber tube, which was done in one case, and resulted in pressure necrosis of the skin tube. One year later he made an œsophagus fistula, and five months following this he united the skin tube to the stomach and œsophagus. The union of the œsophagus fistula to skin tube was made by taking a skin flap from the left side of the neck, cutting toward the midline in such a manner that the sides of the skin could be sutured to the skin tube and œsophagus respectively. He then skin-grafted the defect in the neck. Three weeks later the patient could swallow foods without difficulty and was discharged from the hospital in excellent condition.

Another method attempted at about this time by Hirsch,[10] Jianu [14] and Röepke [15] was the use of the stomach wall in the formation of a tube, which was then pulled up under the skin of the thorax. Hirsch, using cadavers and dogs, made a tube by isolating a longitudinal section from the anterior wall of the stomach, sewing the edges together, at the same time closing the defect in the stomach. This was unsatisfactory because the tube could not be made sufficiently long and the stomach was left too small following the removal of such a large portion of its wall. Jianu then advocated isolating a segment along the greater curvature of the stomach and Röepke did this successfully in one case which he reports. His method of procedure, as described by Myer, was as follows: A midline incision was made from the xiphoid to the umbilicus. The greater omentum was tied off and divided close to the stomach as far as the point where the left gastro-epiploic artery turns on the stomach. The right inferior gastro-epiploic artery was divided two inches from the pylorus. Mattress sutures through the entire thickness of both walls of the stomach were placed 1½ inches distant from and parallel to the greater curvature of the stomach. An intestinal clamp was placed along the suture line or immediately above it, and the stomach divided between the clamp and the layer of mattress sutures. The mattress sutures were then tied and a continuous suture was begun at the duodenal end of the cut and continued out to the end of the isolated portion of the greater curvature, thus converting it into a tube 25 cm. long, which was brought out of the abdominal incision and could be drawn up under the skin of the thorax as far as the cartilage of the third rib. The end of the tube was then opened and fastened

to the skin wound. Myer [17] points out that since the vessels of the tube run in a horizontal direction, fascia necrosis will occur if they are constricted by sutures through the seromuscular coat. Therefore, it is important to engage only the submucosa in the stitch where the tube is anchored to the skin wound. This may be done stripping back the seromuscular coat. Myer also shows that in drawing the tube up under the skin, it is better to have it run subcutaneously than submuscularly, because if infection should occur, it could be combated more readily.

At a second operation thoracotomy was done and a skin tube made to connect the subcutaneous stomach tube and the oral end of the œsophagus. It is obvious that if the oral end of the œsophagus is long enough to reach the stomach tube, no skin plastic need be done, and also if the resection is between the aortic arch and the cardia, the stomach tube can be brought up intrathoracically and united to the œsophagus.

Von Hacker [18] reports a case of resection of a stricture in a thirteen-year-old girl, in which he brought the transverse colon instead of the jejunum up under the skin, and got a perfect result. The child has no difficulty swallowing and eats almost any solid food. There is, however, no apparent advantage in using the transverse colon instead of the jejunum if care is taken to avoid twisting the mesentery of the jejunum, thus causing constriction of its vessels.

In another case he used the jejunum in a similar manner, but only a very short loop. He made a skin tube extending from the clavicle to the gastrostomy opening and used only a very short loop of jejunum to interpose between the stomach and skin tube in order to prevent the formation of a fistula, which has been shown by Blauel [21] to occur almost invariably if anastomosis of skin tube and stomach is attempted, due to the action of the gastric juice. This case also had a complete recovery. He (Blauel) reports three cases, one of which died of empyema, one developed a fistula at the junction of the skin tube and intestine, and one got well.

One of the most brilliant successes is in a case reported recently by Madlener,[24] who advises that œsophagostomy and the formation of the skin tube be done in one sitting except when the freeing of the œsophagus is difficult, and this is rarely the case. In his case an incision was first made parallel to and at the level of the lower edge of the left clavicle, a little to the left of the midline. The advantage of this incision was that through it the œsophagus below the first tracheal ring and in the upper part of the mediastinum could be exposed, and because the lower skin edge of the incision is transverse, it could be used as the upper end of the skin tube. Then two parallel incisions were made, beginning at each end of the first transverse incision, a rectangular piece of skin isolated, and a tube made by sewing the two lateral edges together. The œsophagus was then isolated, divided transversely, and the oral end brought to the surface. Madlener says the transverse division is preferable because there is a better possibility of healing between it and the skin tube than there is when it is incised longitudinally, as
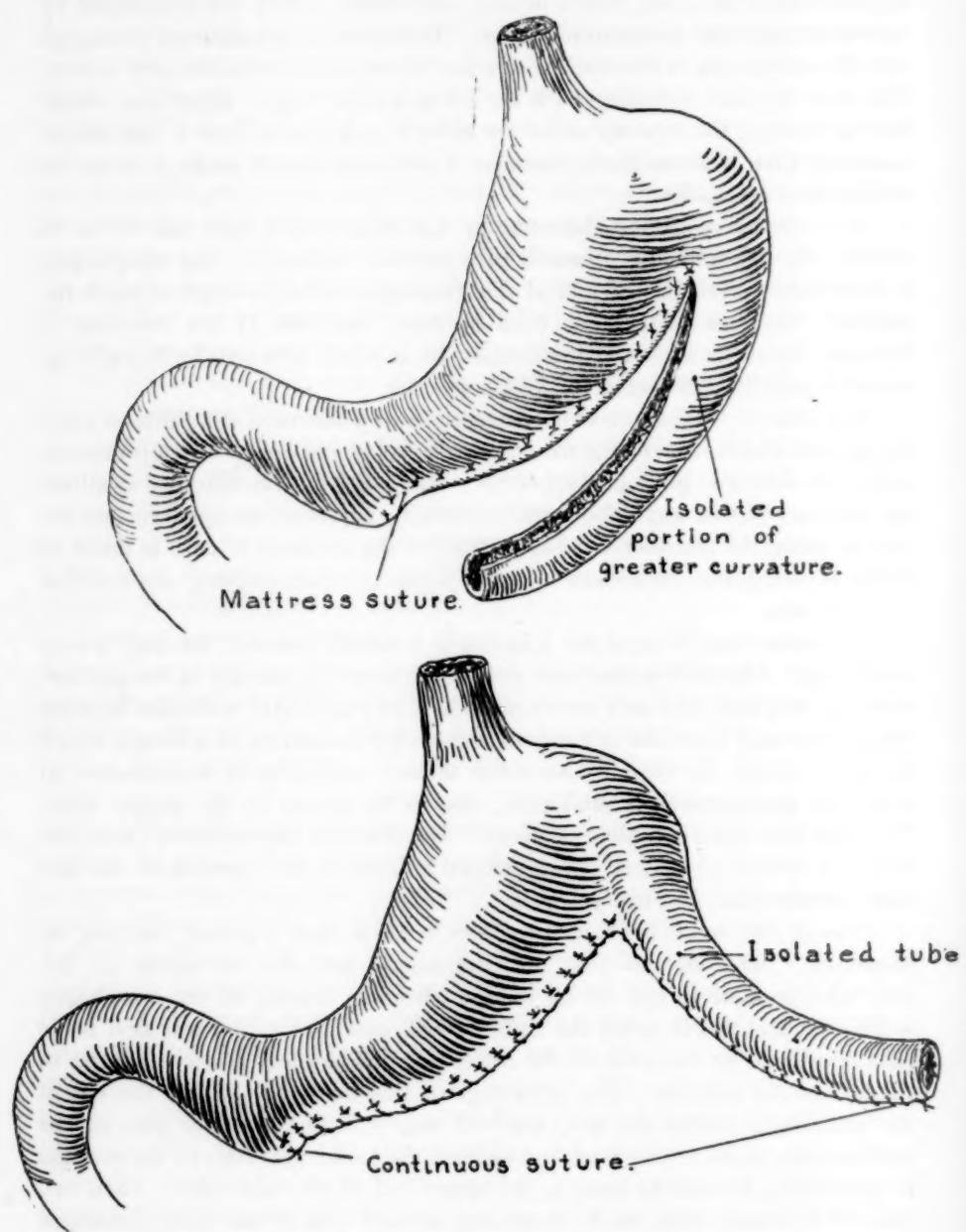
FIG. I.—Jianu-Röepke method of making tube from the stomach.

has been the custom formerly. The skin tube and oral end of the œsophagus were then united and a gastrostomy done.

The defect which was the result of the skin tube formation was corrected by making two lateral incisions 10 cm. long in the infra- and supraclavicular fossa, the skin mobilized and brought over the skin tube, thus covering the first defect but leaving two defects in the clavicular fossæ. These, however, were readily covered over by Thiersch grafts. The object of these two lateral cuts is that it allows the skin edges to be closed over the skin tube without tension and minimizes the possibility of breaking down of the wound. Two weeks later the patient was released, but daily bougies 12 mm. in diameter were passed to prevent occlusion or stricture of the tube. One month after the first operation the patient reëntered the hospital. During this time he had fed himself through the gastrostomy wound. The wounds of the previous operations had practically healed.

Second Operation. Provisional Closing of the Gastric Fistula.—The jejunum is cut across 10–12 cm. below the duodeno-jejunal junction, the oral end clamped and filled with gauze. The mesentery of the aboral end was ligated and divided close to the root of its vessels so that 17 to 18 cm. of jejunum was freed, leaving enough for adequate blood supply to the isolated loop. This loop was brought through an incision in the gastrocolic ligament and the transverse mesocolon up to the surface, being careful to avoid twisting of the mesentery. At this point, by means of an incision through the skin of the thorax, a subcutaneous skin tunnel was made through which the freed end of the jejunum was brought. This tunnel is about 5 cm. long. The skin tube and jejunum were then united by means of skin flaps.

Now follows the lateral anastomosis of the oral end of the divided jejunum with the most convenient point in the distal segment. Thus, there is a Y-shaped anastomosis of the jejunum with the open end extending out of the abdomen. The jejunum is then divided just above the place where the lateral anastomosis was done and the aboral end of the isolated loop anastomosed with the stomach. Healing occurred without reaction and the union of the skin tube and jejunum was per primam.

Two weeks after second operation the entire wound had healed and an 11-mm. bougie could be inserted easily into the stomach from the mouth. This was done frequently, as stricture is very liable to occur at the junction of the skin tube and œsophagus or skin tube and intestine.

Madlener reports that three and a half months after the beginning of the œsophagus-plastic the patient could eat solid food, without even drinking water afterwards, and when he swallows, one can see the distention of the skin tube and peristalsis of the intestinal tube, and that no difficulty is experienced getting food into the stomach, as the force exerted by the muscles of deglutition is sufficient to give the food momentum enough to reach the intestinal tube.

With the X-ray it was demonstrated that the boy could eat 510 c.c.

barium mush in two minutes. First plate in fifteen seconds; second in two minutes.

The lower end of the intestinal tube was seen lying horizontally at the
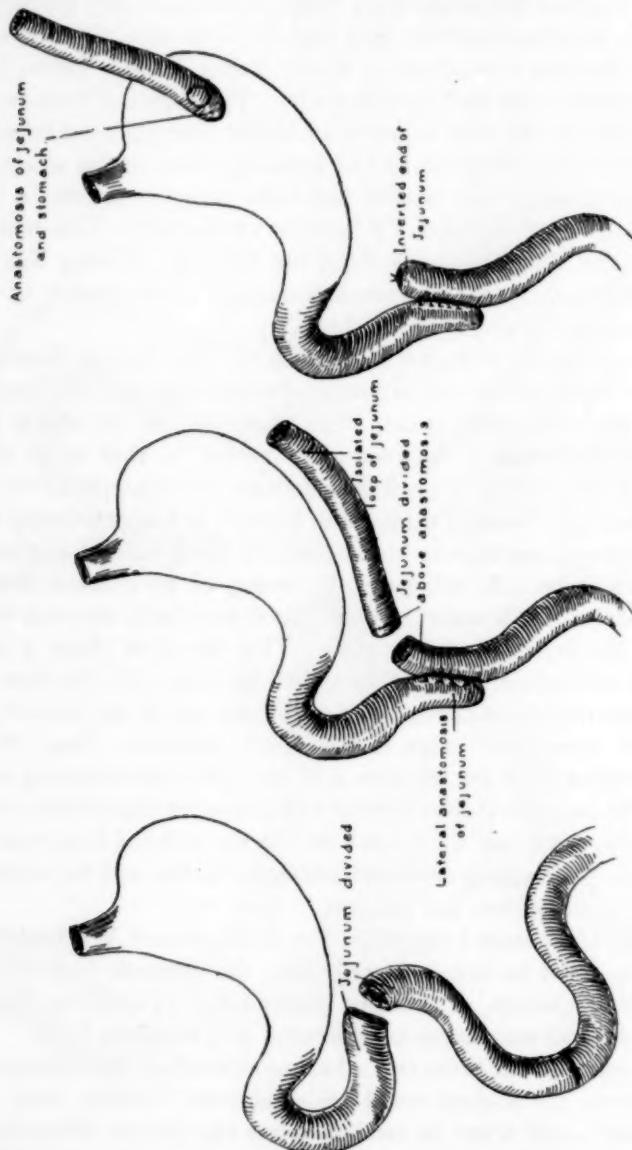
Fig. 2.—Securing a loop from the jejunum to supply the place of the excised portion of the œsophagus.

lesser curvature of the stomach. The only discomfort experienced by the patient was gaseous eructations which occur after meals.

Analysis of the results of the foregoing cases shows that the procedure of choice in cases of stricture and carcinoma depends on several factors. The first and most important consideration is the location of the lesion;

and secondly, the amount to be resected. If the lesion is located in the cervical region, and only 1 or 2 cm. of the œsophagus is to be resected, *e.g.*, for stricture, it is possible to anastomose the ends. When this is done Lapèyre [19] has demonstrated on dogs that it is essential to place the sutures in such a manner that they lie perpendicular to the longitudinal muscle fibres; otherwise, they will pull out and result in leakage. His method is illustrated in the accompanying illustration. Following the operation, bougies should be passed daily to prevent stricture at the point of anastomosis.

If, however, approximation of the ends is impossible after resection, one of several procedures may be chosen. First, both ends of the œsophagus may be closed after resection, and the patient nourished through a gastrostomy opening. Secondly, an œsophageal fistula may be made by bringing
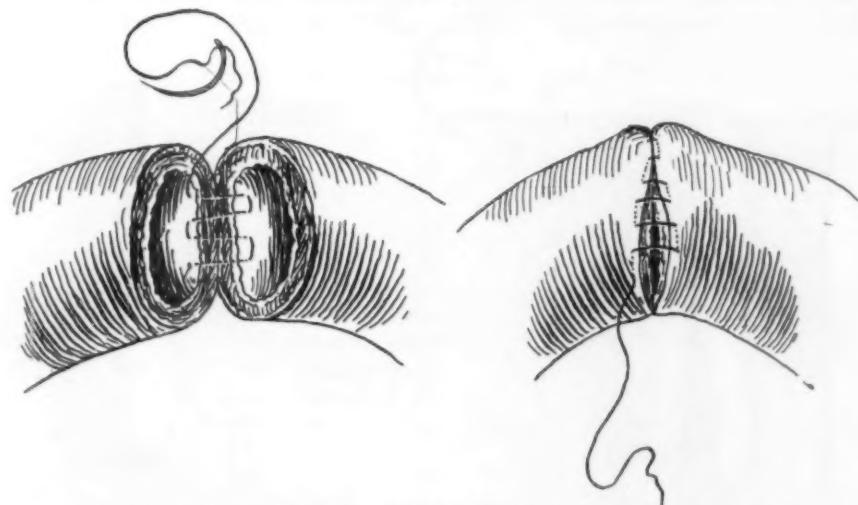

FIG. 3.—Shows sutures placed perpendicular to the external longitudinal muscle layer.

the aboral end out and suturing it to the skin. Thirdly, by means of a skin flap a tube may be made to supply the defect. The first of these three methods is the least desirable from the standpoint of the functional result, but is the simplest. The second gives a slightly better functional result and makes the patient more comfortable, but there is more danger of periœsophageal infection, due to leakage around the wound. The third method gives the best end result of all, if it is successful, because the patient is able to chew his food and swallow it. If the lesion is in the thorax, a plastic operation is the procedure of choice, except when the portion to be resected is at the cardia and it is possible to do an œsophagogastrostomy and supply the defect by the formation of a tube made from the greater curvature of the stomach by the Jianu-Röepke method described above.

When the plastic operation is to be done, it should be performed in several stages, the procedure at each stage being more or less arbitrary. One may do as Madlener did, *i.e.*:

First operation: (1) Formation of skin tube; (2) œsophageal fistula in the neck with its union to the upper end of the skin tube; (3) gastrostomy.

Second operation: (1) Y-anastomosis of jejunum; (2) union of lower end of skin tube and isolated jejunal loop; anastomosis of jejunal loop and stomach.

Or, which might be more advisable, one may at the first operation isolate a loop of jejunum by a Y-shaped anastomosis, bring it out through the abdominal wound and draw it up under the skin of the thorax a short distance, suturing it there. Then anastomose the oral end of the freed loop of jejunum and the stomach by closing the end of the jejunum with a purse-string suture, and uniting the jejunal loop and the stomach as in a gastroenterostomy. The advantage of doing this is that it completes the abdominal work except for the
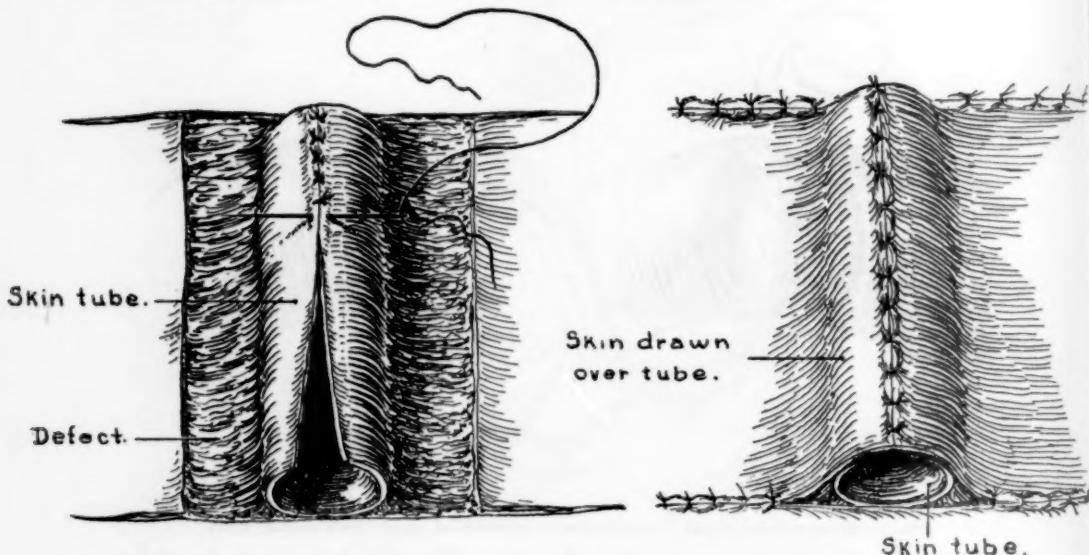
FIG. 4.—Constructing a skin tube to connect œsophagus and jejunal segments.

subsequent closure of the gastrostomy opening. Another advantage of this is that by doing a gastrostomy at the first operation, the patient can be nourished through it and be made better able to withstand the subsequent operations. This is often of importance as the patients are frequently in a very undernourished condition as the result of the œsophageal obstruction.

At a second operation the skin tube is constructed, an œsophageal fistula made and the skin tube united to the œsophagus above and the jejunal opening below. The construction of the skin tube is as follows:

Two parallel incisions are made about 8 cm. apart, beginning at the level of the clavicle and extending to the point where the jejunum opens on the surface. These incisions are a little to the left of the midline and are jointed to each other by incisions between their upper and lower ends. The lateral edge of the inner incision and the medial edge of the lateral incision are then dissected up and sewed together to form a tube. To cover the resulting defect,

the other two edges are drawn over the tube, the result being that the skin tube is subcutaneously placed.

Following this, bougies should be passed daily to prevent stricture until the wounds have healed and the newly-made tract can be used. Then a thoracotomy is done, the lesion resected, closing the cut ends of the œsophagus by inverting them with purse-string sutures. At the same time, the gastrostomy opening may or may not be closed, depending on whether the new tract for the passage of food is healed completely.

The following table is an analysis of twenty-five cases reported since 1871 :

Name	Date		Resected	Loca-tion	Result	Remarks
Billroth	1871	...	0	c.	w.	Cervical fistula made.
Czerny	1877	car.	?	c.	w.	Case followed five months.
Von Bergman	1883	car.	6.5 cm.	c.	d.	Mediastinitis, pericarditis, pleurisy, pneumonia.
Novaro	1883	str.	3.7 cm.	c.	w.	Seen in seven weeeks after operation.
Braun	1891	str.	1-2 cm.	c.	w.	
Bircher	1894	car.	0	t.	d.	Attempted skin tube formation. Patient died at operation.
Czerny	1895	car.	4 cm.	c.	w.	
Rehn	1897	str.	0	c.	d.	Cervical fistula.
Rehn	1897	car.	0	t.	d.	Operation not completed.
Garré	1897	car.	Larynx	c.	w.	Skin plastic in neck.
Garré	1898	car.	9 cm.	c.	w.	Case followed one year.
Sandelin	1899	str.	?	c.	w.	
Schalita	1902	car.	5 cm.	c.	w.	Cervical fistula.
Wullstein	1904	car.	0	t.	w.	Skin plastic plus jejunal loop.
Gluck	1905	str.	0	t.	w.	Skin-tube method.
Bircher	1907	car.	0	t.	d.	Attempted skin tube. Patient died before completion.
Roux	1907	car.	0	t.	d.	Gangrene jejunal loop.
Herzen	1908	str.	0	c.	d.	Gangrene jejunal loop.
Fragenheim	1910	str.	0	t.	w.	Skin plastic plus jejunal loop.
Lexer	1911	str.	0	t.	w.	Modified Roux.
Myer	1912	str.	0	c.	w.	Jianu-Röepke method.
Stieda	1913	str.	0	t.	w.	Skin plastic.
Von Hacker	1919	str.	0	c.	w.	Skin plastic. Case followed four years.
Nicolaysen	1919	str.	0	t.	w.	Jianu-Röepke method.
Madlener	1920	str.	0	t.	w.	Skin plastic.

Analysis of the above twenty-five cases collected from the literature shows fourteen cases with the lesion in the cervical region and eleven in the thorax. Of the fourteen cases in the neck, resection was carried out and in six with one death.

Among the eleven cases with the lesion in the thorax, there are four deaths reported, but it is significant in the last five cases (Madlener, Nocolaysen,[23] Lexer, Fragenheim [12]) there is no mortality, the four deaths occurring in the first six cases, two of these being operated on over fifteen years ago. In these last four cases the skin tube was used in all except one, in which the Jianu-Röepke method was employed. In none of these cases, however, is any attempt made to resect the œsophagus.

This, of course, is not necessary if the operation is done for stricture, but in case of carcinoma it would be necessary to resect a portion if a cure is to be hoped for.

According to these statistics therefore the skin-tube method is one which has been done with excellent results in the last ten years and should be the method employed in case of carcinoma and stricture of the œsophagus, when cure by dilatation with bougies is not possible.

BIBLIOGRAPHY

[1] Billroth: Arch. f. Chir., Berl., 1871. Verhandl. Deutsche Gesellsch. f. Chir., 1879.
[2] Czerny: Zentralbl. f. Chir., Leipzig, 1877.
[3] Garré: Verhandl. d. Deutsche Gesellsch. f. Chir., 1898. Arch. f. Klin. Chir., 1898.
[4] Bircher: Zentralbl. f. Chir., Leipzig, 1907, xxxiv.
[5] Von Hacker: Arch. v. Klin. Chir., Berlin, 1908, lxxxii.
[6] Myer: Tr. Am. Surg. Ass., 1909, xxvii.
[7] Janeway and Green: J. A. M. A., vol. liii, 1909.
[8] Wullstein: Zentralbl. f. Chir., Leipzig, 1908, xxxv. Deutsche Med. Wchnschr., 1911, lviii.
[9] Herzen: Zentralbl. f. Chir., 1908, No. 8.
[10] Hirsch: Zentralbl. f. Chir., 1911, No. 48.
[11] Lexer: München Med. Wochenschr., 1911, lviii.
[12] Fragenheim: Arch. f. Klin. Chir., 1911, xcv.
[13] Vulliet: Semaine Med. Par., 1911, xxxi.
[14] Jianu: Deutsch Zeitschrift f. Chir., 1912, vol. cxviii.
[15] Röepke: Zentralbl. f. Chir., 1912, No. 46.
[16] Stieda: Arch. f. Klin. Chir., 1913.
[17] Myer: Ann. Surg., Sept., 1913.
[18] Von Hacker: Deutsch. Med. Wchnschr., 1913, xxxix.
[19] Lapèyre: Montpelier Med., 1914, xxxviii. Montpelier Med., 1913, No. 67. Arch. Gen. de Chir., Par., 1913.
[20] Von Hacker: Zentralbl. f. Chir., 1919, xlvi, 1–6 and 264.
[21] Blauel: Zentralbl. f. Chir., 1919, No. 18.
[22] Roux: Zentralbl. f. Chir., 1919, No. 33.
[23] Nicolaysen (Kristiania): Zentralbl. f. Chir., 1919, No. 46.
[24] Madlener: Deutsch. Zeitschrift f. Chir., 1920.

OBSERVATIONS UPON THE SURGERY OF THE LUNG

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In looking over the literature of the surgery of the lung since the publication of my first paper on Empyema in the Annals of Surgery, 1907, 45, 373, I have been impressed with the fact that some of the principles I then advanced and which I hoped would be generally accepted and utilized, have been ignored or overlooked by many medical men. It is in the hope that surgeons generally will give these facts further consideration, and by applying them prove their efficacy and their limitations, that I am presenting this paper. The great deterrent to operative work on the lung has been the fear on the part of the internist as well as the surgeon, of the pneumothorax and the collapse of the lung. To this must be added mediastinal flutter. It was this fear that led to the use of the negative and positive pressure apparatus to enable the operator to maintain the lung in expansion during the progress of his operative manipulations.

The first question then is: How dangerous is pneumothorax *per se?*

Artificial pneumothorax has now been practiced for a number of years with the definite purpose of collapsing the lung and putting it either temporarily or permanently out of business. The unsatisfactory results of this procedure have been due to the simple reason that it does not set up an inflammatory pleuritis and consequently does not provide against a reexpansion of the lung by causing adhesions between the collapsed lung and the chest wall, so that as the gas is absorbed the lung again expands and the relief is found to be only transitory. If when these injections into the closed pleural cavity are made we could only devise some method of exciting adhesions between the pleuræ of the collapsed lung and the parietes, we should attain our object and secure the permanent removal of the lung from its usual functional activity, and obtain the rest necessary for the cure of the tuberculous focus.

The failure of this method to offer a permanent compression of the lung has led to the operation of removing the chest wall down to the pleura and filling the cavity with a portion of the scapula, fat, depressed skin flap, or a transplant of the pectorales major and minor. This is nothing more than a modified Estlander's operation, and has as yet not been performed often enough nor have the cases been watched long enough to give definite information of its efficacy.

In our operative work, we have the same result when pneumothorax occurs, provided the operation is sterile, as we have when we inject gas into the pleural cavity. The air is gradually absorbed, the lung expands, and resumes its normal functional activity. After sterile stab or gunshot wounds which have been hermetically sealed, the same result obtains, provided there is no effusion of serum or of blood, and the patient makes an uninterrupted and complete recovery.

A very different picture presents itself if the pneumothorax is caused by an escape of air from an opening in the lung itself into the closed pleural cavity. Here we have a constantly increasing pressure of air in the closed space with a consequent compression of the lung, the displacement of the mediastinum and the heart to the opposite side, causing marked circulatory and respiratory symptoms. In these cases the indications are clear. An incision in the chest wall should be made immediately, and if no other complications are present, particularly hemorrhage, the insertion of a tube of just sufficient calibre to allow the escape of the air, will at once relieve the pressure, enable the injured lung to expand, and in all probability the pulmonary wound will close of itself without further operative interference. As soon as the pulmonary wound has closed the drainage tube may be withdrawn.

At the present time, extra-pleural thoracoplasty is employed most frequently of all the open operations for bronchiectasis and pulmonary tuberculosis. This method has the advantage over the compression of the lungs by gas injections into the closed pleural cavity of producing a permanent compression of the lung. It has the disadvantage of an increased mortality, as well as the putting of the lung out of function permanently. Some surgeons feel that this operation should be reserved for the tuberculous cases only; while the bronchiectases should be treated by incision and drainage or by lobectomy. It is more than probable that with increased experience the tendency of the thoracic surgeon will be to adopt the latter method, because this permits the remaining portion of the lung to resume its normal function, an important consideration in all cases. Judgment and experience will have to determine the procedure in each individual case. So far as I have been able to determine by studying the literature and examining some of the cases which have been subjected to the operation of extra-pleural compression for bronchiectases, while they may show improvement, and the amount of expectoration may be diminished, they are not cured and are liable to a return of their symptoms from time to time.

This operation may be performed under local anæsthesia by a series of nerve blockings on the twelve thoracic nerves of the affected side. The best place to make the puncture is over the articulation of the rib, with the transverse process of the vertebra, deflecting the needle as soon as it comes in contact with the bone—first, to the space above the rib line, and second, to that below. Eight to ten cubic centimetres of novocain thrown into each of these spaces ordinarily suffices to produce a complete nerve blocking, making it possible to resect a considerable portion of the chest wall without discomfort to the patient. At least fifteen, and preferably twenty minutes from the injection of the anæsthetic should be allowed to elapse before the operation is begun. This is definitely the point of selection when we remember that " at first each intercostal nerve lies near the head of the rib below the intercostal artery and directly covered by the costal pleura and the endothoracic fascia." We must also remember that the twelfth nerve comes through the

intervertebral foramen between the twelfth dorsal and first lumbar vertebra.

One must determine at the time of the operation whether the patient's condition will allow of a complete excision of all of the ribs and a compression of the whole lung, or whether for safety's sake the operation must be performed in stages. If a complete operation cannot be performed, it is generally considered preferable to take the lower ribs first, so as to compress the lower lobe, in order to avoid the possibility of the drainage from the cavities being drawn down into the more dependent portions of the lung and producing serious symptoms. In the cases of large cavities, the operation under local anæsthesia has the distinct advantage that the patient, being conscious, is able to cough and expectorate any secretion that may be pressed out of the cavities during the operative procedure. In case the patient is able to stand the complete operation at a single sitting, the Schede operation is the better, and the incision for the operation gives by far the best approach to the chest wall.

It has been claimed that sixty-six per cent. of cases operated upon for tuberculous cavities by this method in the hands of foreign surgeons have been successful. While I am not confident that these statistics have been sufficiently well collated to be of great practical value, I am convinced that the position that I took more than twenty years ago is correct and that cases of single tuberculous cavities in one lung will be benefited if operated upon.

Our experience during the war demonstrated rather forcibly the fact that pneumothorax caused by a wound in the chest wall was not a condition to be dreaded by the surgeon. I think the great majority of us who had the opportunity of seeing these cases on the other side will remember numerous incidents where patients were brought into the hospital even with large mutilating wounds that produced little or no disturbance of respiration or circulation. It is true, the lung on the injured side was collapsed, but how frequently was it possible for us, when the symptoms were caused by a machine-gun bullet and the wound was sterile, to close these wounds and see the patient progress to a complete recovery.

Many surgeons have recognized the fact that there was no immediate danger from the pneumothorax when operating on the pleural cavity. It seems strange that physicians generally should have such a dread of pneumothorax as they do. In the surgical history of the Civil War, ii, 540, chest wounds were recorded, and yet complications due to the pneumothorax were recorded in less than half a dozen. John B. Murphy, in an address on " Surgery of the Lung," delivered at the Forty-ninth Annual Meeting of the American Medical Association, held at Denver, Colorado, in 1898, said: " That there is little shock or discomfort produced by the admission of air into the pleural cavity, has been shown by numerous accidents to the chest, experiments and operations, extending from the time of Hippocrates to the present day." With all of our experience in experimental, operative and accidental opening of the pleural cavity we should have overcome the dread of pneumothorax by this time, and yet we find that this dread is the greatest

deterrent to the reference of lung cases to the surgeon for operation.

Many years ago while experimenting on animals, I was able to demonstrate this conclusively, and since that time I have never hesitated to open the chest cavity freely in order to perform any necessary surgical operation. The recognition of this fact has enabled me on several occasions to remove cancers of the breast which were attached to the ribs and even invaded the pleura—in several instances removing the whole of the anterior portion of four ribs, including the chest wall and pleura, and closing the wound by a large pediculated abdominal flap; in one instance I not only removed four ribs with the parietal pleura, but also two cancerous nodules in the lower lobe of the lung, doing a partial lobectomy. Two weeks later I removed the supraclavicular glands in this same patient, and she lived for two years after the operation. This operation was done some years ago.

The question of mediastinal flutter must be considered in this connection. Murphy recognized this, and it seems to me that it is wise in this connection to quote rather freely from what he said: " The most pronounced and dangerous manifestation observed in my experiments was when a medium-sized opening (two inches in length) was made in an intercostal space and the air allowed to pass in and out with some opposition. The lung on the open side gradually contracted to the hilum: the mediastinal septum and contents flapped to and fro in respiration, like a sail during a lull; when the dog inhaled, the mediastinal septum concaved greatly to the uninjured side; when he exhaled, it convexed to the opposite side. The chest ceased to be a cylinder for the piston—the diaphragm in the respiratory act. The mediastinal septum became a second diaphragm which contracted and destroyed the aspirating or piston power of the true diaphragm. With this motion of the septum, there was comparatively no exchange of air in the lung, there was merely a variation in the shape of the lungs; the septum soon became emphysematous and ruptured. The dogs in this experiment had rapid, panting respiration, which shortly ceased. The respiration could be easily restored by placing the hand over the opening in the chest wall with the diaphragm, either concave or convex. By keeping the hand in position for a few minutes, the cyanosis would disappear and the animal reacted to his normal condition, proving that it was not the displacement of the mediastinal organs to right or left, not the diminution in the respiratory area, but the absence of secure pressure which forced the air out of the lung on the healthy side in expiration and aspirated it in inspiration.

"I am convinced that the dyspnœa following opening of the pleural cavity is due to the vibration of the mediastinal septum and contents, destroying the piston action of the diaphragm. In support of this theory, I wish to call attention to the methods of relief reported by different operators in cases of dyspnœa following opening of the pleura in surgical operations on the lung or pleura. The operators closed the opening regardless of the condition of the lung, as far as contraction and expansion were concerned, still the patients were relieved. Delageniere filled a pleural cavity with

water to prevent dyspnœa after he had resected the rib and removed a very large quantity of pus from the cavity. It can be seen from this case that the respiratory area was not increased, the quantity of blood in or out of the lung was not changed, and the pneumogastric filaments were not interfered with, but the chest cylinder was rendered complete by the immobilization of the mediastinal septum. Covering the opening in the chest with gutta percha to prevent the intake and egress of air would have accomplished the same result. When a drainage tube has been inserted into the pleura and dyspnœa occurs, the occlusion of the tube relieves it. I found that by placing a forceps on the collapsed lung and drawing it into the opening the dyspnœa was immediately relieved and respiratory movements were at once resumed. Forceps placed on the hilum of the lung, immobilizing the septum, had the same effect. I also noted that if the lobe were secured in the aperture and only partially filled it, it did not take part in the respiration, but the dog was relieved, due, I believe, to the steadying of the mediastinal septum. The plugging of the trap-door orifice with the lobe, or suturing it to the margin, was the best method for the relief of the dyspnœa. Carl Bayer, when operating in a case, drew up the collapsed lung and sutured it to the margin of the wound; the symptoms of dyspnœa and collapse disappeared and this portion of the lung filled and emptied in respiration."

Some operators, in doing lobectomy, have left a long suture attached to the stump, coming out through the wound in the chest wall, so that in case of the mediastinal flutter traction on the diseased lung could be made and the condition relieved. Undoubtedly in this condition there is a lack of proper filling of the healthy lung on its side of the mediastinum. If the anæsthetist at the time of the operation is provided with an intratracheal catheter which can be quickly inserted into the trachea and attached to a rubber bulb, the collapse of the lung can be quickly overcome by pumping in air, expanding the lung until it provides sufficient pressure against the mediastinum to overcome this condition.

The great majority of the operations on the lung can be done without excision of the ribs. Lilienthal and Tuffier have both improvised rib dilators in order to increase the space between the ribs during the operative manipulations. In these cases a single incision, running around the chest wall, separating the intercostal muscles at about the seventh or eighth rib, and extending from the costal margin to the vertebral articulation, will usually give an abundance of room, and provide against the retraction of the chest which necessarily results from a rib resection. Through this incision, it is possible to close an open bronchus, to arrest a hemorrhage, or even to perform a lobectomy. In case a rib dilator is not available, I have found that it was possible to dilate the ribs sufficiently by manual stretching and maintain them in that position by means of a pair of abdominal retractors. This is not so convenient as the rib dilators, and requires two extra assistants, but it answers the purpose when the dilators are not available.

The anæsthetic, in all lung surgery, is an important desideratum. Wherever possible, I prefer to operate under local anæsthesia. Where this is impossible gas and oxygen, and finally, if necessary, ether. I am convinced that one of the important considerations is to leave the lung after every operation in a condition where its full expansion may be attained at the earliest possible moment. The ideal lung surgery is to provide for a filling up of the pleural cavity by its normal viscus, rather than by dropping down the chest wall to close the cavity. We must therefore provide against extensive effusions, hæmothorax, or long-continued pneumothorax. Our experience in France led us to the conclusion that in traumatisms of the chest-wall opening the pleural cavities, it was wise to close the openings in the chest at the earliest possible moment, and I can see no reason why these conclusions should not apply quite as well in civil as in military surgery.

In my article on empyema referred to earlier in this paper, I spoke of the possibility of expanding the lung, even with the chest cavity wide open. I have used this method so extensively that I am thoroughly convinced of its efficacy. It is true that the lung collapses when there is an opening in the chest wall larger than the diameter of the main bronchus. It will remain collapsed so long as the patient remains in complete anæsthesia. If, on the other hand, the anæsthetic is stopped, and the reflexes are allowed to reassert themselves, irritation of the pleura causes coughing, and each time that the patient coughs the collapsed lung dilates. In other words, in the effort of coughing, the air not escaping through the glottis from the healthy lung is forced over into the collapsed lung, and by this means the lung can be expanded to such an extent that it will actually protrude through the wound in the chest. It is my habit, when operating on the chest, to make sure that this expansion of the lung takes place before I close the chest incision.

If the points that I have hinted at in this paper are observed, it is evident that there is no longer any reason why we should not remove tumors of the chest wall involving the pleura, or tumors of the lung itself. There can also be no question that abscesses of the lung and the cavities resulting from bronchiectasis should be attacked and drained. Foreign bodies may be readily removed, but, on the other hand, one would not advocate the removal of a foreign body through the lung that could be reached by means of the bronchoscope.

Lobectomy has now been performed so frequently that it too must be regarded as an established operation. The question of the after treatment of these wounds is important. In all sterile cases, I believe the wound should be closed completely. It is true that in a number of instances we will have a very considerable pleuritic effusion, but this may be withdrawn by means of the aspirating syringe, if necessary. In the abscess cases and the infected cases generally, drainage of course is essential. Frequently it is found preferable to attach the viscera to the parietal pleura at the point of the opening into the abscess cavity, and if a bronchus is open at this point it may be closed at a later operation. The openings into the bronchi are some-

times difficult to close. An occluding suture will sometimes suffice. In other cases it is essential to do a partial lobectomy. In the lobectomies, I prefer the direct suture method, using a mattress stitch, to the use of the Paquelin cautery. In two of the cases where I employed a Paquelin, the eschar dropped off and caused pleuritic trouble. In cases of hemorrhage of the lung, the indications now are distinctly for an opening of the chest and a direct closure of the bleeding point. This is particularly true if the hemorrhage is of any considerable amount, as the larger vessels in the lung are not controlled by the collapse of the organ.

It is not purposed in this paper to go into the question of empyema; and yet I feel that it would not be complete without a word on this subject. I feel very strongly that we should not have to deal in the future with the chronic empyemas which formerly called for the Estlander and Schede operations, the Fowler-Delorme decortication, the Ransohof gridiron operation, and my own suggestion with regard to the relief of the adhesions. I note in the recent literature a good deal of difference of opinion in regard to when an empyema should be operated upon: and yet I cannot help feeling that the profession should be more in accord in regard to this subject than it seems to be. When one considers that an effusion of fluid in the pleural cavity compresses the lung and decreases the aerated surface in proportion to the amount of compression, and that the pleural surfaces become adherent so that the expansion of the lung on the withdrawal or absorption of the fluid becomes impossible, it seems rational at least to urge that operation should be done early enough to prevent this condition. I believe that all effusions which do not show a tendency to decrease, and where the X-ray shows a distinct compression of the lung itself, should be aspirated. The aspirated fluid should be examined, and a careful record made of the bacteriological findings. It is a well-known fact that in the pneumococcus cases, aspiration of even a moderate amount of fluid is often sufficient to provide for a rapid absorption. By means of the X-ray one may determine whether the lung expands after the withdrawal of the fluid. Should the fluid reaccumulate, a second operation should be done, and again the position of the lung determined. Recent adhesions yield readily and allow of a very considerable and finally even a complete expansion. If neglected they become very firm, bind the lung in its abnormal position, and make it impossible for it to expand under any normal respiratory processes. Moschowitz has contended that almost, if not all, of the cases of empyema are due to the rupture of lung abscesses. My experience proves that this is true in the great majority of cases. It is frequently quite possible to make out at the time of operation the point of rupture. The important point to determine, if possible, is when the patient has sufficiently recovered from the pneumonic process to render operative procedure safe. On the other hand, I have operated a number of times and found definite areas of pneumonia, and yet the patient has made a perfectly satisfactory recovery. But there can be no question that the mortality from empyema is very much greater in those cases that are oper-

ated upon during the progress of pneumonia than after the resolution is complete.

I wish that medical men would aspirate more frequently and more completely than they do, so that the lung might be relieved from the compression of the effusion. I believe this will render the operation for empyema much simpler and the recovery more complete. An empyema having become an established fact, operation is essential. If it is of recent origin, simple incision through the intercostal space in the most dependent position possible, about the eighth interspace in the posterior axillary line, should be practiced. This can be done readily under local anæsthesia and a drainage tube inserted. If this is not sufficient to allow the lung to expand and the effusion to disappear, it will be necessary to do the more radical operation, and in this case the original incision should be enlarged between the ribs, the ribs separated, and the adhesions broken up or incised until the lung can be made to expand and fill the pleural cavity. If the separation of the adhesions is not sufficient, and the lung still remains collapsed, decortication should be resorted to.

Briefly, we may summarize the present indications for operations on the lung as folows:

First: For tuberculous cavities where gas injections into the pleural cavity, either because of too rapid absorption of the gas or because adhesions prevented the collapse of the lung, extra-pleural thoracotomy should be performed. This may be completed or in stages, depending upon the condition of the patient.

Second: For bronchiectasis, extra-pleural thoracotomy may be performed, although incision and drainage or lobectomy offer a better chance of a radical cure.

Third: For foreign bodies which cannot be removed by bronchoscopy, thoracotomy, with direct removal by incision through the lung, would be the method of choice.

Fourth: For hemorrhage with increasing hæmothorax, compression of the lung and displacement of the heart and mediastinum, thoracotomy with suture of the bleeding point is indicated.

Fifth: For abscess, thoracotomy and drainage of the abscess, attaching the pulmonary pleura about the opening of the lung to the parietal pleura in order to effect direct drainage, will give the best results.

Sixth: For tumors of the chest wall, including the ribs and pleuræ, complete removal with a pediculated skin flap from the abdomen has been successful.

Seventh: For tumors of the lung, thoracotomy and direct excision by partial or complete lobectomy offers the only chance of curing the patient.

Eighth: For empyema, early and frequent aspiration, followed, if necessary, by intercostal incision and drainage.

If these methods are not efficacious, one of the radical operations should be performed.

GANGRENE OF AN EXTREMITY AS A COMPLICATION OF PNEUMONIA

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Case Report.—R. W., female, aged seven, is one of four children, all of whom are healthy and sturdy. The family history is negative. The patient had "pneumonia" at two years of age and again at five years and at six had whooping cough. Otherwise she has always been well and strong.

On February 12, 1921, she was seen by one of us (E. E. M.) at seven o'clock in the evening. At this time she had a temperature of 105°, pulse 146 and respirations forty and appeared very ill. She was semi-delirious, restless and tossing about. Her cheeks were flushed, alænasi dilating with each respiratory movement; she was dyspnœic, somewhat cyanotic and the usual picture of a pneumonia. Examination of her chest revealed a consolidation of the lower lobe of the left lung. Previous to this, the child had been ill for four days, but had been treated by her parents. The suggestion that the patient be moved to a hospital where better attention could be given, was not acceded to.

The following morning, the child seemed about the same, the lung condition was unchanged and the heart sounds, though fast, were clear and distinct. She was seen in the afternoon and was in about the same condition. At nine P.M. she was seen and appeared to be in crisis. Stimulation was instituted and the patient carefully watched. A few hours later she seemed better and the next morning had a normal temperature and appeared well over her attack. From this time she was seen daily and continued to improve, the convalescence seeming normal.

On February 17th, four days after the crisis, the patient appeared to be doing nicely and no complications had occurred. In the afternoon she suddenly developed an excruciating pain in the left leg, just above the knee. When seen she had no elevation of temperature, the pulse was increased to 120 and there was nothing abnormal to be seen about the leg. It was placed upon pillows with instructions for it to be kept quiet, as the possibility of a phlebitis was considered.

The following day the leg showed a rather startling condition. It was discolored by large red and blue areas extending from the knee to and including the toes. There was present a definite line above and below which a difference in temperature could be made out. This line was at the junction of the middle and lower thirds of the femur. The leg was decidedly colder than the other and no pulsation could be felt in the leg or foot. Any movement or attempted movement was accompanied by great pain and there seemed to be exquisite tenderness over

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the whole thigh and leg. The limb was surrounded by hot water bottles and elevated. Early in the afternoon of the same day a consultation was held and it was decided to move the patient to the hospital. She was taken to Mercy Hospital the day following. The gangrene which was of the typical dry type rapidly became more marked and a line of demarcation formed just below the knee, there being an isolated area of gangrene over the patella. The thigh was swollen and tender and no pulsation could be felt in the femoral artery.

The pulse rate began to increase and as the chest condition seemed reasonably safe, it was thought unwise to wait longer and amputation was performed February 23rd. No constriction tests were made of the circulation and no tourniquet was used in the operation. Temporary constriction was made by the hands of an assistant and amputation was done just below the middle of the thigh. The skin bled fairly freely, the muscles were somewhat pale and the bone marrow decidedly pale, but it was decided to risk it at this level and the subsequent course showed that the structures were viable. There were no thrombi in the vessels at the point of amputation and a dissection of both arteries and veins in the specimen showed none. The blocking was apparently high in the femoral.

The patient's further convalescence was without incident and she left the hospital March 18th in first-class condition. At no time was there any evidence of an endocarditis or disease of any other blood-vessel, artery or vein, and no other diseased condition of any type was found.

REMARKS

A few years ago, thrombosis of a vein in an extremity as a complication of pneumonia was considered a rarity. Da Costa recorded his first case in 1894 and this seems to be the first reported. Since then a large number have been described and there is quite a literature on the subject. Arterial thrombosis or embolism occurring in an extremity following a pneumonia seems to be extremely rare. In fact, embolism of the arteries of the extremities from any cause other than endocarditis is very unusual. In the cases of gangrene of an extremity reported as following pneumonia, it has not always been clear whether the condition has been a thrombosis or embolism. Gibson, who reported three cases in 1903, and found no mention in the literature of others, thinks the condition an embolic one and that the emboli come from the fibrinous masses which are seen in the pulmonary capillaries and larger venules in the hepatized area. Recently, Kline and Winternitz have shown that the capillaries in the consolidated lung are extensively plugged with fibrin. This would seem to lend weight to Gibson's theory of the manner of production.

The association of a pulmonary condition and an embolism or thrombosis of a peripheral blood-vessel, of course immediately arouses interest as to which is primary and whether the lung condition may not be an infarction. This question is a pertinent one in cases where a phlebitis or an endocarditis

FIG. 1.—Post-Pneumonic Gangrene of leg.

is present, but with an undiseased heart and a clear previous history a clear-cut pneumonia followed by an arterial embolism or thrombosis seems to be cause and effect.

It is easy to understand an embolus traveling from the lungs into the left auricle and ventricle out into the systemic arterial circulation, but difficult to imagine an arterial disease (other than endocarditis) giving rise to a pulmonary embolism, with the capillary sieve between.

A rather careful search of the literature for the past twenty-five years has revealed very few reports of cases of this condition. Gibson reported three in the ANNALS OF SURGERY in 1903. Frazier, in Keen's Surgery, mentions but gives no details of two cases. Osler states that he saw one case and mentions Kredel's case of popliteal thrombosis and speaks of Seidelmann's case of gangrene of fingers and thumbs of both hands. He also mentions Hjelt's case of embolism of the abdominal aorta and Aldrich's case of embolism of the lenticulo-optic artery. Dr. Wm. F. Lockwood (personal communication) relates a case of gangrene of the arm following pneumonia. Dr. Mercur of Pittsburgh (personal communication) tells of a case similar to the one herewith reported, except there was a possibility of an endocarditis in his case.

BIBLIOGRAPHY

Gibson—ANNALS OF SURGERY 1903, p. 380.
Conner—Archives Internal Medicine, March, 1914.
Riesman—Medical Clinics of North America, January, 1921.
Steiner—Johns Hopkins Hospital Reports, vol. xv, p. 189.
Keen's Surgery.
Osler—Modern Medicine.
MacCallum—Text-Book of Pathology.

CENTRAL BONE ABSCESS*

BRODIE'S ABSCESS; CHRONIC SUPPURATIVE OSTEOMYELITIS

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The recognition of central isolated bone abscesses has received scant attention and reported cases are few in number. The process is simple and its pathology well understood. The main difficulty seems to be in its differential diagnosis. It must be differentiated from bone cysts and tumors, syphilitic osteitis and periostitis, and bone tuberculosis. When recognized and properly treated, its cure is certain. The diagnosis is made by the long duration, periodicity, and characteristic symptoms of pain at night in association with the X-ray picture. Too many of these abscesses are unrecognized and the patients are condemned to needless and prolonged suffering.

Pathology.—In its simplest form a Brodie abscess is a small, well localized, circumscribed, pyogenic abscess situated deeply in the medullary cavity or cancellous tissue of a long bone, without any external fistula or sequestration, and it is characterized frequently by an extensive productive osteitis, often of many years' standing.

There are two general locations for them, first, in cancellous bone, giving in the X-rays a central, translucent area (Fig. 2), surrounded by dense bone, and a second variety, situated in the medullary cavity (Fig. 1), evidenced in the X-rays by the presence of a uniform, diffuse swelling of the bone which looks like an exuberance of normal bone. There is no resemblance to new growths. In the medullary situation there may be no translucent area in the centre of the sclerosed bone (*e.g.,* Fig. 1), as we find in Brodie abscesses in cancellous tissue, or there may be such an area (Figs. 3 and 4). The medullary cavity may be much diminished in diameter by the production of new bone on the endosteal surface while above and below the medullary cavity is entirely shut off from the remainder of the cavity by new bone. Thus, nature limits the spread of the infection. In the medullary abscess the pus is often slight in amount, and this, in association with the small destruction of bone about the abscess, together with the production of dense, surrounding new bone, may result in there being no translucent, central area evidenced in the röntgenogram (Fig. 1). In the cancellous variety (Fig. 2), on the other hand, the spongy bone becomes easily necrosed and there is a liquefaction of the necrosed particles, leaving behind a definite cavity seen in the röntgenogram. There may be a single, small cavity or there may be several small cavities. There may be large, solitary cavities (Fig. 2), reaching the size of a pigeon's egg or a hen's egg. These large, solitary cavities are usually

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* Read before the New York Surgical Society, May 11, 1921.

found in the mataphyses. There is no tendency to sequestration though the lesion extends over many years.

Complications.—Infrequently a spontaneous fracture may occur in case the new bone formation is less than the bone destruction. A sudden fall, or trauma, may wake up the latent virulency of the infection, or break the abscess capsule, so that a typical acute osteomyelitis may result. Some of the misconceptions of the lesion are shown in these quotations: Stewart's Surgery, Edition of 1921, states that " Brodie's abscess is a tuberculous abscess near the epiphysial line of a long bone." Keen's Surgery, vol. i, page 285, says, " Tuberculous abscesses of the long bones nearly always occur in the epiphyses rather than the diaphyses, the head of the tibia being a favorite site (Brodie's abscess)." It is thought generally that Brodie attributed these bone abscesses to tuberculosis, but there is not a suggestion in the appended quotations from Sir Benjamin that he thought this to be etiology. There is as much truth in this observation, probably, as there is in the equally fallacious statement that most ischiorectal fistulæ are tuberculous. Brodie's abscess is caused by pyogenic organisms, most frequently staphylococci.

To illustrate how incomplete the knowledge of even the X-rayist is, I quote from the latest X-ray book on " Injuries and Diseases of Bones and Joints," by Baetjer & Waters, Hoeber, 1921. All that they say of Brodie's abscess on page 168 is this: " In a certain number of cases we shall find a single, punched-out area, definitely circumscribed, situated in the *cancellous* head of a bone about an inch from the joint. Such a localized osteomyelitis we speak of as Brodie's abscess. The upper ends of the tibia and humerus seem to be the favorite locations for such conditions."

I was much interested in looking up Sir Benjamin Brodie's account of his discovery of this lesion in his book, published in 1850, entitled, " Pathological and Surgical Observations on the Diseases of the Joints." On page 288 he gives his account of how he discovered the lesion:

" Occasionally chronic inflammation of the articular extremity of the tibia terminates in the formation of an abscess in the centre of a bone, but contiguous to the joint. An abscess of this kind is attended with an extraordinary degree of suffering, such as not only would justify amputation, if there were no other means of obtaining relief, but would induce the patient cheerfully to submit to operation. Fortunately a less formidable mode of cure is within our reach. My first knowledge of this disease was derived from the following case:

" The patient was twenty-four years of age, and was first seen in October, 1824, who had had pains of excruciating character for twelve years. All treatment failed, so finally he made up his mind to have the limb amputated, which was done. On examining the amputated limb, it was found that a quantity of new bone had been deposited on the surface of the lower extremity of the tibia. The deposition of new bone was manifestly the result of inflammation of the periosteum at some former period. It was not less than one-

third of an inch in thickness; and, when the tibia was divided longitudinally with a saw, the line at which the new and old bone were united with each other was distinctly to be seen. The whole of the lower extremity of the tibia was harder and more compact than under ordinary circumstances, in consequence, as it appeared, of some deposit of bone in the cancellous structure; and in its centre, about one-third of an inch above the ankle, there was a cavity of the size of an ordinary walnut, filled with a dark colored pus. The bone immediately surrounding the cavity was distinguished from that in the neighborhood by being of a whiter color, and of a still harder texture, and the inner surface of the cavity presented an appearance of great vascularity. The ankle-joint was free from disease.

" It seems highly probable that, if the exact nature of the disease had been understood, and the bone had been perforated with a trephine, so as to allow the pus collected in its interior to escape, a cure would have been effected without the loss of the limb, and with little or no danger to the patient's life. Such, at least, was the opinion which the circumstances of the case led me to form at the time; and I bore them in my mind, in the expectation that, at some future period, I might have the opportunity of acting on the knowledge which they afforded me, for the benefit of another patient.

" The second patient (page 292) was a man, twenty-three years of age, who was seen in February, 1826. It was regarded as a case of chronic periostitis and was treated for this by incision only, without penetrating the bone. A second operation was necessary because of lack of relief, in which the bone was trephined and the abscess opened, with a cure." But let us abstract Brodie's account of this case which cleared up the pathology for him. "Mr. B., at that time twenty-three years of age, consulted me in the beginning of February, 1826. There was considerable enlargement of the right tibia, beginning immediately below the knee, and extending downwards, so as to occupy about one-third of the length of the bone. He complained of excessive pain, which disturbed his rest at night, and some parts of the enlarged bone were tender to the touch. The knee itself was not swollen, and its motions were perfect. He said that the disease had begun more than ten years ago, with a slight enlargement and pain in the upper extremity of the tibia; and that these symptoms had gradually increased up to the time of my being consulted. Various remedies had been employed, from which, however, he had derived little or no advantage.

" Having inquired into the circumstances of the case, I was led to regard it as one of chronic periostitis, and I adopted the following method of treatment: An incision was made longitudinally on the anterior and inner part of the tibia, extending from the knee four inches downwards, and penetrating through the periosteum into the substance of the bone. The periosteum was found considerably thickened, and the new bone, which had been deposited beneath, was soft and vascular. The immediate effect of the operation was to re-

lieve the pain which the patient suffered, so that he slept well on the next and every succeeding night. After this I prescribed for him a strong decoction of sarsaparilla. The wound gradually healed; and it was for some time supposed that a perfect cure had been accomplished. The enlargement of the upper extremity of the tibia, however, never entirely subsided; and in August, 1827, pain was once more experienced in it. At first the pain was trifling, but it gradually increased; and when I was again consulted, in January, 1828, Mr. B. was unable to walk about, and quite unfit for his usual occupations. At this period the pain was constant, but more severe at one time than at another, often preventing sleep during several successive nights. The enlargement of the tibia was as great as when I was first consulted, and the skin covering it was tense, and adhering more closely than is natural to the surface of the bone. Some remedies which I prescribed were productive of no benefit. The patient's suffering was excruciating, and it was necessary that he should, if possible, obtain immediate relief. The resemblance between the symptoms of this case and those of the first case described was too obvious to be overlooked. It appeared highly probable that they depended upon the same cause, and I therefore proposed that the bone should be perforated with a trephine, in the expectation that an abscess would be discovered in its interior. To this the patient readily assented; and, accordingly, the operation was performed in the beginning of March, 1828.

" My attention was directed to a spot about two inches below the knee, to which the pain was especially referred. This part of the tibia was exposed by a crucial incision of the integuments. The periosteum now was not in the same state as at the time of the former operation; it was scarcely thicker than natural, and the bone beneath was hard and compact. A trephine of middle size was applied, and a circle of bone was removed, extending into the cancellous structure, but no abscess was discovered. I then, by means of a chisel, removed several other pieces of bone at the bottom of the cavity made by the trephine. As I was proceeding in this part of the operation, the patient suddenly experienced a sensation, which he afterwards described as being similar to that which is produced by touching the cavity of a carious tooth, but much more severe; and immediately some dark-colored pus was seen to issue slowly from the part to which the chisel had been last applied. This was absorbed by a sponge, so that the quantity of pus which escaped was not accurately measured, but it appeared to amount in all to about two drachms. From this instant the peculiar pain belonging to the disease entirely ceased, and it has never returned. The patient experienced a good deal of pain—the consequence of the operation—for the first twenty-four hours; after which there was little or no suffering. The wound was dressed lightly to the bottom with lint. Nearly six months elapsed before it was completely cicatrised; but, in about three months from the day of the operation, Mr. B. was

enabled to walk about and attend to his usual occupations. He continued well when I last saw him on the 7th of January, 1832; and the tibia was then reduced in size, so as to be scarcely larger than the other leg. No exfoliation of bone had ever taken place.

" Since the occurrence of this case, five similar cases have come under my care, in every one of which a complete cure was at once obtained by the same operation; so that I have the satisfaction of knowing that in my own practice as many as six individuals have been enabled to preserve limbs which must inevitably have been amputated if the dissection of the limb in one other case had not made me acquainted with the real nature of the disease under which they laboured."

GENERAL OBSERVATIONS BY BRODIE (PAGE 296).

" Chronic abscess of the extremity of the tibia may exist during a very long period before it interferes with the neighboring joint. In one case the patient had labored under the symptoms of the disease for as many as eighteen years before I was consulted. The symptom by which the disease is indicated in the first instance is pain in the affected part, which is more or less of an intermitting character. The pain gradually becomes more severe, but still it is intermitting. For some time the patient may suffer so little from it that he is not prevented from attending to his usual occupations; then, without any manifest reason, a paroxysm occurs, in which the pain is intense, he is utterly disabled, and even unable to quit his bed. This gradually subsides and he has another interval of ease. As the disease goes on, the bone becomes increased in size, the general health becomes affected, and the mind probably is rendered miserable and irritable by long-continued suffering. In one case, whenever the patient began to use the limb the knee itself became inflamed, and there was an effusion of fluid into the cavity of the synovial membrane. The case of Hendrow, already recorded in the sixth chapter of the present volume, explains the probable cause of this complication to have been the attempt of the abscess to make its way into the knee-joint, through the cartilage of the tibia. If, in this case, the application of the trephine had been much longer delayed, we cannot doubt that the joint would have been destroyed, and that there would have been no means of relieving the patient except by amputation.

" Now, I do not say that in all cases in which the combination of symptoms exists which I have just described, the surgeon should at once conclude that there is an abscess in the interior of the bone, and that the trephine should be applied for the purpose of making an opening into it. For the most part there can be no danger in deferring the operation until it has been ascertained whether such remedies as mercury, sarsaparilla, or iodide of potassium (which are known to have the power of subsiding chronic inflammation of bone), will afford the desired relief. But if these methods fail, I cannot doubt that it is the duty of the surgeon to perforate the bone

with the trephine. Hitherto, in no instance in which I have performed the operation have I failed in discovering the abscess. But, even if abscess should not exist, I can conceive that the perforation of the bone, by relieving tension, and giving exit to serum collected in the cancellous structure, might be productive of benefit; and at all events the operation is simple, easily performed, and cannot itself be regarded as in any degree dangerous."

Symptoms.—Brodie's abscesses are usually found in adults. There is frequently a history of osteomyelitis in childhood which is almost forgotten " Growing " pains in childhood should be looked upon with suspicion and should not be dismissed with the casual diagnosis of " rheumatism." This is particularly true if the pain is localized to one spot. Röntgenograms should be taken to rule out foci of infection or tuberculosis.

In Brodie's abscess, after some trauma, or severe bodily exertion, or without any recognized etiology, a dull ache appears in some localized area, to become boring and severe, much worse at night, being apparently accentuated by the warmth in bed. A characteristic symptom is that the pain comes and goes, sometimes worse in wet weather, hence the etiology is referred to as " rheumatism." There is frequently a definite, localized, unvarying spot of tenderness on pressure over a particular locality, or there may be no localized point of tenderness. There may be an occasional slight rise in temperature, but this is not constant. The most frequent locations for such abscesses are the head of the humerus, femur, and tibia, and the shafts of the humerus, radius, femur, and tibia. The pain frequently extends over a period of many years. When near joints, there may be muscular spasm, and an intermittent hydrops of the joint.

A röntgenogram should clear up the diagnosis. In both the cancellous and medullary Brodie abscesses, there is an overdevelopment of dense bone, usually producing a swelling of the bone. In the centre of this dense bone, in the medullary type, there may or may not be a central, translucent area, the abscess itself. If there be this translucent area, then the diagnosis is at once evident. Frequently there is no light central area, and then the mistaken diagnosis is usually made of syphilitic periostitis. If the Wassermann is negative, then the bone should be opened (see Case II). If the Wassermann is positive, then intensive antisyphilitic treatment (salvarsan intravenously, mercury injections, potassium iodide by mouth) should be given. The pain will very quickly disappear if the process is syphilitic. If there is a Brodie abscess combined with constitutional syphilis, then the pain will not be relieved by the antisyphilitic treatment; then the bone should be opened and the abscess drained. In the cancellous type, there is apparently always a central translucent area, though I know of no reason why it may not be absent.

Alexis Thompson (*Edinburgh Medical Journal,* New Series, Vol. XIX), has analyzed 161 cases. Out of 145 cases, in which the early history was

available, there had been an antecedent osteomyelitis in childhood in 122. The most frequent bone affected was the tibia. Seventy-four per cent. of all the abscesses were in the tibia.

LOCATIONS

Tibia,
$\begin{cases} \text{Upper end} \ldots\ldots 63 \\ \text{Lower end} \ldots\ldots 42 \\ \text{Upper and lower..} \quad 1 \\ \text{Middle third} \ldots.. \quad 2 \\ \text{Not stated} \ldots\ldots 11 \end{cases}$

119, or 74 per cent.

Femur .... 18, or 11 per cent.
Humerus .... 18, or 11 per cent.
Radius .... 4, or 3 per cent.
Ulna .... 2, or 1 per cent.

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INCIDENCE OF BRODIE'S ABSCESS

In the Presbyterian Hospital since 1913 (seven years), there have been 115 cases of chronic, suppurative osteomyelitis of the long bones. Among these were found three cases of undoubted Brodie's abscess, or 2.6 per cent. Several were uncertain, so were excluded.

Differential Diagnosis.—Syphilitic osteitis and periostitis may be ruled out by a negative Wassermann and the lack of a history of infection. A somewhat similar area of softening sometimes occurs with gummata, but in this case the surrounding bony wall is then soft and not ivory-like. The associated night pains in syphilitic osteitis are very similar to those in Brodie's abscess, but in the latter they are more intermittent and changeable in intensity, while in the former the night pains, when once they have begun, are persistent and increase in a consistent ratio, finally becoming intolerable. Probably the commonest mistake is in referring the pains due to Brodie's abscess to " rheumatism."

Bone cysts lack the surrounding sclerotic bone, and there is an absence of night pains, with no increased temperature, nor is there any local tenderness. Bone tumors are not to be confused with Brodie's abscess because of the irregularities in the shadows caused by the soft tissues having imbedded in them plaques of bone, and there is a thinning out of the normal bone caused by the pressure of the tumor. Tuberculosis of bone is essentially a destructive process and leads early to sinuses and sequestra, and there is an absence of evenly sclerosed bone such as occurs in Brodie's abscess, which is a constructive lesion. The periosteum is rarely thickened in tuberculosis of bone. These cases have been treated for neuritis, sciatica, rheumatism, syphilis, etc.
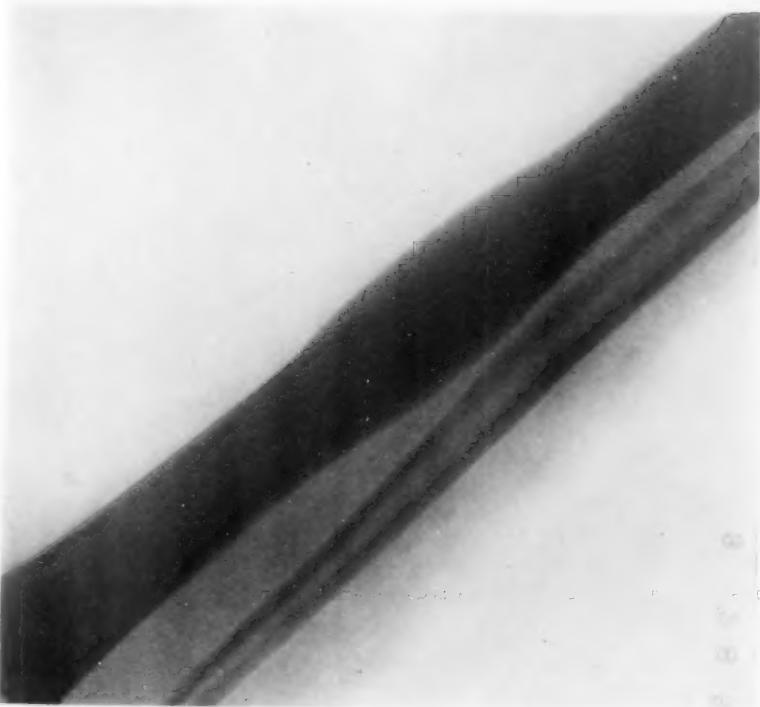
FIG. 1a.— Case I. Medullary variety. Anteroposterior view. No central translucent area indicating abscess. Operation showed that abscess was too small to be apparent. The whole diameter of bone seems to be evenly enlarged.
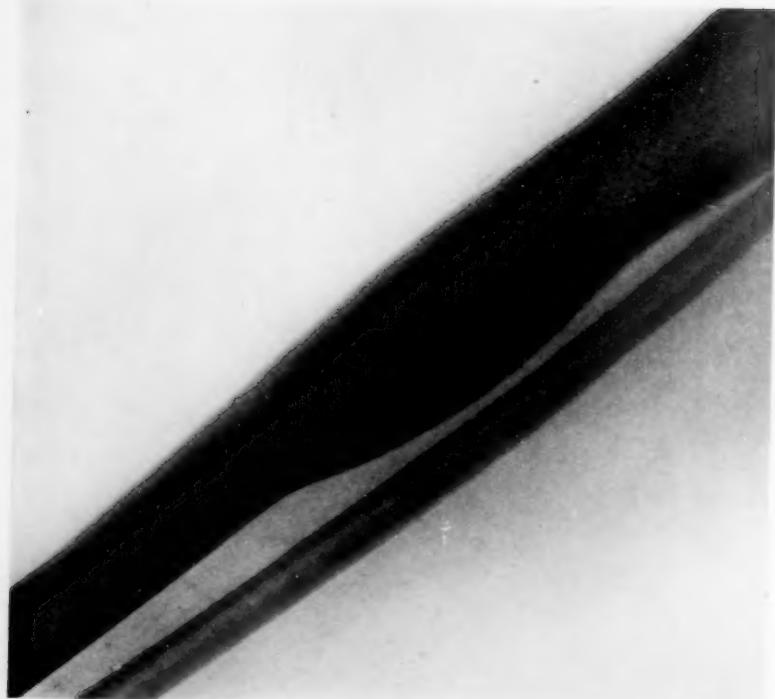
FIG. 1b.—Case I. Lateral view. The new production of bone seems to be larger on outer side.
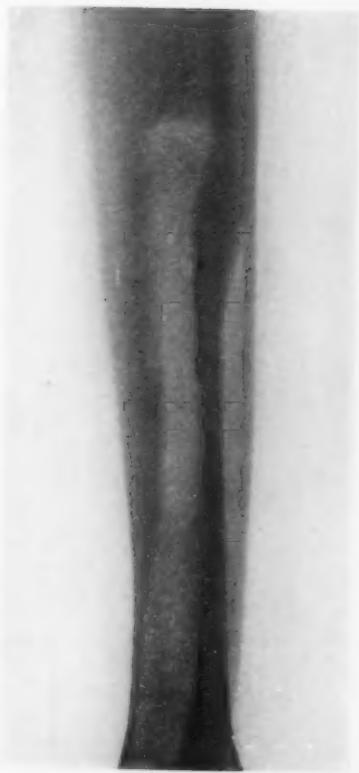
FIG. 1c.—Case I. Shows the 4-inch furrow
made through the bone, opening the abscess
located in the medullary cavity.

FIG. 2.—Case II. Cancellous variety. Large solitary abscess seen in lower tibia, surrounded by dense new bone. Kindness of Doctor Imboden. The patient had been treated for four years intensively for syphilis without any relief of his severe night pains.

CASE REPORTS: CASE I (Fig. 1).—The patient was a man of twenty-one years of age who had never been sick with typhoid, pneumonia, scarlet fever or osteomyelitis. He was a college student, athletic, and in the best of health. Thirteen years ago he was operated upon for acute appendicitis and two years ago for inguinal hernia. Three years previously he received a stab wound on the middle of the right tibia which healed up in three or four days without pus formation. Two years ago he began to have a dull ache in the right tibia, which later became boring in character, worse at night and after strenuous bodily exertion. The pain would come and go and was diagnosed as "rheumatism." Six months ago the pain became much worse, keeping him awake at night. A röntgenogram was taken by a Western surgeon which showed the same tibial enlargement as in the present radiograph, but that surgeon said that he did not know what the swelling was due to; also another surgeon expressed his ignorance of the etiology. Early in April, 1921, the patient came into the author's hands. His pain had become worse so that he would rarely have an undisturbed night's sleep. There was a slight swelling, palpable, on the middle of the right tibia, evidently an enlargement of the bone, but it was not tender and there was no localized point of tenderness. The location of the pain seemed to be fugitive. Wet weather did not seem to influence the pain, but physical exertion increased it. A radiogram was taken and showed a uniform, fusiform swelling, three inches long, on the middle of the right tibia, involving the whole circumference of the bone, but more prominent on the outer side of the bone. There was no central translucent area. The X-rayist made a diagnosis of syphilitic osteitis. A Wassermann blood test was negative. The author then made a probable diagnosis of Brodie's abscess and operated upon the man, after applying a tourniquet about the mid-thigh, by a vertical incision, six iches long, carried to the bone. The periosteum was normal, not thickened, and not more than normally adherent. It was reflected from the bone on either side and a groove was made in the enlarged area through dense, sclerosed bone. An abscess was finally opened in the medullary cavity, which was of the diameter of a quill and was three inches long. The walls of this cavity were smooth, with no covering granulation tissue nor any endosteum. The whole thickness of the entire cortex was very dense, hard, and enlarged. Above and below, the medullary cavity was shut off from the remaining medullary cavity by dense, new bone. The fluid in the cavity was thin and whitish, and all that remained of the marrow tissue was some whitish strings which looked like fibrin. A furrow (Fig. 1, C) was made through the whole length of the dense, eburnated, anterior wall, three inches long and half-an-inch wide. Cultures were taken of the pus, and the stringy, fibrinous tissue was removed. No curetting was performed of the smooth walls, in which there was no sign of any sequestration. The upper part of the wound was closed with silkworm-gut sutures, and through the lower part

were placed three Carrel tubes, without any packing, but with vase-lined gauze along the wound edges. Dakin's solution was thereafter instilled every two hours. On the fourth day no organisms were found in smears, so that the wound was entirely closed secondarily (fourth day postoperatively) with gas and oxygen anæsthesia, without drainage. The cultures taken at the time of the original operation were contaminated, so the causative organism is unknown, though probably it was staphylococcus, which is the most frequently found etiology in these abscesses.

CASE II (Fig. 2).—Was kindly given to me by Doctor Imboden. It shows a large, solitary abscess in the cancellous tissue of the tibia near the ankle-joint. The man was fifty years of age and had been treated for four years very intensively for syphilis without any benefit. Drainage of the abscess resulted in a cure.

CASE III (Fig. 3).—A man thirty-five years of age, had typhoid fever twelve years ago. Soon after, he began to have severe shooting pains in lower third of right tibia which prevented sleep at night. Recurring attacks of night pains, coming and going. Present attack has lasted for five weeks, slight tenderness over bony swelling of tibia. Examination shows a two-inch-long moderately tender thickening of the middle of the right tibia. In the centre of the sclerosed bone is seen a central translucent area in the radiogram.

Operation by Doctor Darrach, February 1, 1916. There was a cavity in the centre of the tibia, 3x4x4 cm., containing thick, yellow pus without odor. It was lined by pale red granulation tissue. The cortex of the bone was thickened and was hard. The bone was drilled with the Albee drill over the thickening. Thick pus escaped at the second drilled spot. The bone was removed over the cavity and a Mosetig-Moorhof iodoform plug filled the cavity. A culture of pus showed bacillus typhosus. The patient resumed work two months after being discharged. The sinus discharged for one year after the operation, under the old method of packing, despite the iodoform plug. Brickner says (ANNALS OF SURGERY, vol. lxv, 1917, page 485), " I have not found recorded any case of pure medullary abscess of typhoid origin." Case III is such an instance. He also says that the medullary abscess cannot be recognized as such röntgeno-graphically, because of the lack of translucent central area. Cases III and IV are instances of medullary abscesses with central translucent areas, easily made out in the radiograph.

CASE IV (Fig. 4).—R. G., History 17142. A man aged twenty-five years. February 4, 1913. Doctor Eliot. Nineteen years ago he fell, severely injuring the right shin, below the knee. Pain lasted for six weeks. Four years after this a sudden attack of severe, lancinating pain in the same spot. This lasted for two nights; then two years ago a similar attack, lasting three nights. One month ago, the same area had severe pain which has persisted, much worse at night. The bone has become gradually swollen; examination shows a fusiform, slightly tender swelling of the upper third of the right tibia.

FIG. 3.—Case III. Typhoidal medul-
lary variety with central translucent area.
Note the sclerosed bone surrounding
the central collection of pus. Abscess
caused by bacillus typhosus twelve years
after the original infection.

FIG. 3.—Case III. Cavity filled
with Mosetig-Moorhof iodoform
plug. With this method of treat-
ment patient had a sinus for one
year.

FIG. 4.—Case IV. Medullary abscess with translucent
central area surrounded by dense bone in upper portion of
tibia.

X-ray showed dense osteitis with translucent central area. That leg measures 4 cm. more in diameter than the opposite one. At the operation (Doctor Eliot), the upper third of the tibia was found very much hypertrophied, and in the medullary cavity, just below the tubercle of tibia, was a small pus pocket, culture of which gave a pure growth of staphylococcus aureus. An opening was made through the bone to the abscess cavity, which was allowed to fill with blood clot, and it was covered by rubber tissue. No record of after history.

Treatment.—The old, classical treatment was opening of the abscess through the dense bone followed by packing, the wound being allowed to granulate up from the bottom. This required months before healing was complete. Bevan advanced the treatment to immediate closure, following swabbing out with hydrogen peroxide and then 70 per cent. alcohol. His results were excellent. It occurred to me that our knowledge, gained during the war, of secondary suture of infected wounds might well be applied here, following a sterilization with Dakin's solution. This seems a little surer than Bevan's method, and does not delay the healing more than four or five days. The closed cavity is left to fill up with the blood clot.

In Case I there was primary union of the entire wound, and the lad was discharged, cured, on the twelfth day, and he has remained cured since.

Literature.—The literature on this subject is scant. It is usually grouped under chronic suppurative osteomyelitis, so that one must wade through the voluminous literature of this large subject to find instances of Brodie's abscess. It would be better, in my opinion, if a distinct, separate heading were to be made in our classifications for this entity, which presents a very different picture from the acute, or the usual chronic, suppurative osteomyelitis.

BEVAN (*Surg, Clin. of Chicago,* June, 1919, p. 743) reports two cases, both of the medullary variety, and gives his method of immediate closure.

MILLER (ANNALS OF SURGERY, 1918, vol. lxvii, p. 460) reports a case of the medullary variety, with remarks.

MARTIN (ANNALS OF SURGERY, 1917, vol. lxvi, p. 254) reports three cases in a few lines: He does not state specifically to which variety the three cases belong, but says that in these three cases the radiographs failed to differentiate the abscess cavity from the shadows made by the thickened, sclerotic bone, hence one may infer that they belonged to the medullary variety.

DOWD (ANNALS OF SURGERY, 1906, vol. lxiv, p. 112) reported a patient with Brodie's abscess who had symptoms for nine years. It was of the medullary variety, with a central translucent area surrounded by dense bone.

BRICKNER (ANNALS OF SURGERY, vol. lxv, 1917, p. 483), in an interesting and instructive article on Brodie's abscess, cites three cases, all of the medullary variety.

BRYANT and BUCK, vol. iii, p. 316, give an excellent account of Brodie's

abscess, and in vol. iii, p. 289, there is a röntgenogram of a Brodie's abscess with a central, translucent area in the lower end of the radius, and on p. 321 they narrate the case of a man with a Brodie abscess in the upper fifth of the shaft of the femur.

ALEXIS THOMPSON (*Edinburgh Medical Journal,* New Series, vol. xix) has collected and analyzed 161 cases of Brodie's abscess.

CONCLUSION

Given a tender swelling of a bone in which traumatic periostitis, cyst, new growth and syphilis (negative Wassermann) can be ruled out, when associated with intermittent night pains, such a swelling should always be explored and the medullary cavity opened. The soft parts should then be closed over the cavity except for space sufficient to allow Carrel's tubes to be inserted. Dakin's solution should then be used through the tubes every two hours until smears show an absence of organisms, when the cavity can be completely closed with confidence that the wound will promptly heal without a sinus forming.

PEPTIC ULCER, PRIMARY AND SECONDARY*

By John B. Deaver, M.D.

of Philadelphia, Pa.

The operation of gastroenterostomy, in about two per cent. of cases, is followed by secondary ulcer, marginal, or at the margin of the new opening, or jejunal, at a point distant to the opening. According to Gosset it was not until 1899, seventeen years after the operation of gastroenterostomy had first been performed, that the first case of jejunal peptic ulcer was described. The case was reported by Braun, and concerned a patient who had developed this unpleasant aftermath one year after the gastroenterostomy had been done.

Statistics show that these ulcers may occur from a few days to many years after the primary operation. The shortest known interval is ten days, while at the other extreme, seven years are known to have elapsed between operation and secondary ulcer formation. These ulcers present the same characteristics as the primary ulcers and like them may perforate into the free peritoneal cavity or develop fistulous connections with other viscera. In a series of seventy-nine jejunal ulcers reported by Gosset, twenty-four had perforated, and thirteen had developed internal gastric fistulas, of the latter ten were jejuno-colic, one gastro-colic, and two jejuno-gastro-colic.

Primary peptic ulcer arises in the portion of the alimentary canal where gastric juice is normally present. The duodenum is the most frequent site, the stomach is involved about one-fourth as often as the duodenum, while primary jejunal ulcer is a very rare occurrence. These ulcers may be acute or chronic.

The acute peptic ulcer is primarily a medical condition, the treatment of which has been so carefully developed by Sippy and his followers. Einhorn's duodenal bucket also represents a useful therapeutic agent in the treatment of these ulcers, inasmuch as it enables nourishment to be given to patients who are unable to take it in the natural way. This affords temporary relief, and if operation is resorted to, it has helped to bring the patient to a state where surgery will be not only safer but in all probability curative.

As a preparation for operation medical treatment of chronic ulcer also has its usefulness, in fact in many instances this is the wisest course to pursue, but it has its distinct limitations, for in the last analysis the chronic indurated callous peptic ulcer belongs to the domain of the surgeon. Prolonged medical treatment of this type of ulcer is what I would term pussyfooting, in other words it is courting disaster in the shape of hemorrhage, perforation and, in a certain percentage of cases, carcinoma.

While opinions differ as to the question of carcinoma developing on ulcer, the surgeon who does a large number of operations for the treatment of peptic ulcer, and who has submitted the removed ulcers to microscopic study, realizes the danger to be one that has to be reckoned with.

It is after the surgical treatment of peptic ulcer, either by gastroenterostomy alone, or combined with excision of the ulcer, or by pylorectomy, partial gastrectomy, or subtotal gastrectomy, that medical treatment has its greatest field. It takes three weeks or more for the margin of a gastroenterostomy to heal. In order, therefore, to obtain the best results from surgery, it is of the utmost importance to institute judicious medical treatment, mainly in the form of alkalies, immediately after operation and to continue it for at least a month. The administration of alkalies after a posterior gastroenterostomy is adopting nature's manner of neutralizing the acid gastric juice through the medium of the bile and the pancreatic secretion which reaches the stomach by way of the new stoma. This is generally considered to be the rationale of the cure, and not the drainage of the new opening, or the putting of the ulcer, if not excised, at rest.

If, after a gastroenterostomy, with an open pylorus, the stomach, whose secretion is highly acid, empties more freely by way of the new opening, the conditions are favorable for the formation of secondary ulcer at or near the gastrojejunostomy. This naturally leads to the question of the cause of these secondary ulcers. The consensus of opinion is that they are of toxic origin, due to embolic infection from a primary focus, such as the mouth, the tonsils, the teeth, and the appendix. I can only repeat my frequently stated belief that the appendix is the most common source of such infection. Furthermore, the arrangement of the terminal vessels along the lesser curvature of the stomach favors embolic obstruction, while necrosis, or a break in the continuity of the mucous membrane together with exposure of these lesions to the corrosive action of the gastric juice completes the setting for the drama. Chronic and subacute appendicitis followed by primary peptic ulcer is not unusual. That duodenal or gastric ulcer may be followed by perforation of a chronically diseased appendix is well illustrated by the following case.

Male, aged sixty-five years, admitted to the Lankenau Hospital, Philadelphia, giving a typical history of gastric ulcer symptoms of many years' duration, which were preceded by symptoms suggestive of chronic appendiceal dyspepsia. A diagnosis of gastric ulcer was made and operation advised and consented to. At operation a large chronic indurated ulcer was found on the middle of the lesser curvature of the stomach; the pylorus being patulous, a circular sleeve resection was made with end-to-end anastomosis. The operation was one of considerable moment and the patient's condition was none too good. After the resection was completed I carried my hand down to the site of the appendix; the cæcum could not be lifted with ease and in view of the patient's condition it seemed best to stop here and close the abdomen. Six days later there was evidence of oncoming peritonitis, ·accompanied by exacerbation of pain, hiccough and nausea, but no vomiting. Peristalsis was subnormal in the lower and exaggerated in the upper abdomen, there was marked tenderness to rectal touch, and difficulty in emptying the bladder. The patient had some enlargement of the prostate but had had no trouble in passing urine before the present condition. My first thought was leakage at the line of the stomach

suture, with peritonitis and intestinal paresis, but on second thought the presence of marked rigidity and tenderness in the appendiceal region suggested a ruptured appendix. The latter proved to be correct, for at operation the ruptured appendix was found, with pus in the pelvis and also pathological evidence of chronic disease. After removal of the appendix and drainage, the patient made an uneventful recovery.

Ulceration of the proximal jejunum occurs very rarely independently of operation. Ulcers occurring on the jejunum and not far distal to the gastro-intestinal anastomosis are closely related etiologically to those which develop at the gastroenterostomy site itself and which are spoken of as gastrojejunal or marginal ulcers. I can see no very good reason for separating these two types of ulcer pathologically, though their symptomatology is usually distinct.

The jejunal type of post-operative ulcer is more prone to acute perforation than is the gastrojejunal or marginal ulcer. This type of ulcer was formerly relatively more frequent than the gastrojejunal or marginal ulcer, since many more anterior than posterior gastrojejunostomies were done in the early period of gastric surgery. The underlying disease which caused the original ulcer may also be responsible for the jejunal or the gastrojejunal or marginal ulcer. Other causative factors comprise defect in the mechanics of the operation, or in the material used for suture; or the highly acid gastric juice, or the presence of adhesions at the site of the anastomosis.

The greater frequency of gastrojejunal or marginal ulcer after anterior gastrojejunostomy and after posterior long-loop operations in which no entero-anastomosis was done, lends support to the theory that they are due to the corrosive action of the hyperacid gastric juice; as does also the less frequent occurrence of marginal ulcer where a gastroenterostomy has been made in the presence of low acidity or anacidity.

The symptomatology of the condition is not greatly unlike that of the original ulcer. The radiographic proof of some obstruction of the new opening is very important evidence. While gastrojejunal or marginal ulcer is the most common cause for a recurrence of symptoms approaching in severity those before the operation and which were relieved by the operation, we must not lose sight of the fact that the nervous individual, the subject of chronic ulcer and upon whom operation is done, will not lose all of his nervousness and therefore will still complain. Here again where a diagnosis of marginal ulcer has been made it is not out of place to try a course of medical treatment before subjecting the patient to operation, which in the end is generally the only thing that will offer permanent relief, provided the diagnosis is correct.

The medical treatment of secondary ulcers is, of course, the same as for the primary disease. Einhorn claims to have brought about a cure in some instances by introducing nourishment by means of the duodenal bucket passed through and beyond the gastroenterostomy opening, which at the same time puts the ulcer at rest.

Treatment.—In the surgical treatment of any form of peptic ulcer it is

understood that all foci of infection are to be removed whenever possible The treatment of gastrojejunal or marginal ulcer to be curative must be operative.

The nature of the operation and its gravity will depend upon the following factors: the condition of the patient; the previous operation; the extent and degree of organization of adhesions; the degree of exudate surrounding the ulcerated area, and the presence of a fistulous connection with a neighboring viscus.

The condition of the patient calls for practically all the routine examinations used in the primary cases, namely, blood pressure, blood count, serological examination, the various kidney functional tests, possibly also the preparation for direct blood transfusion, and of course X-ray and fluoroscopic study. The latter are of the utmost importance in determining the probable amount of surgery that may be called for. In some cases a careful pneumoperitoneal study may be made. As in all surgical cases, the pre- and postoperative treatment are as important as the operation itself.

The first step in the operation is the treatment of the adhesions (if present) before the ulcer can be demonstrated either by sight or by palpation. In disposing of adhesions only those should be disturbed that interfere with good exposure of the field, or in other words, only those that will help to make the geography of the field and the operation to be performed more certain. The field of the anastomosis can be examined by displacing the transverse colon with the great omentum upward. If the ulcer cannot be definitely located and recognized it will be better to make an anterior gastrotomy and evert the site of the anastomosis, when any existing doubt can be dispelled and the truth revealed. What to do with the ulcer will depend upon its size, location, appearance, the amount of induration and the degree of involvement, if any, of the transverse colon and the presence of a fistulos tract.

In the case of a small ulcer with little or no induration, simple excision or destruction with the cautery, preferably through a gastrotomy wound, followed by closure will suffice. Sometimes the ulcer is so large that in excising it there is danger of encroaching upon the peritoneal cavity. In such instances it is important to provide against leakage by suturing either the proximal or the distal limb of the jejunum to the stomach, well beyond the opening. Where this is not feasible, it will be best to excise the anastomosis; this entails the removal of the part of the stomach included in the ring around the anastomotic opening, and division of the proximal and distal limbs of the jejunum close to the opening. With the anastomosis and the ulcer exposed the first step in the dissection is the separation of the transverse mesocolon from its attachment to the stomach; this may be comparatively easy, or it may be very difficult, depending entirely upon the extent and degree of induration surrounding the ulcer, also the presence of a fistulous communication with the colon, the stomach or the small intestine; the presence of a fistula will indicate the necessity of making a partial or complete excision of the viscus in-

volved. When the margin of the opening in the transverse mesocolon has been fastened to the limb of jejunum making a part of the anastomosis, or to the line of suture of the jejunum and stomach, the separation is rendered both difficult and uncertain and it is not necessary for me to say adds materially to the seriousness of the operation. Therefore, it is my practice in making a posterior gastroenterostomy to make the opening in the transverse mesocolon nearer to the vertebræ than to the colon, so that in the event of a marginal ulcer the ulceration would not be so likely to encroach upon the colon. This may or may not be of moment. But I believe it is important especially if conditions later on make it necessary to separate the transverse mesocolon from its attachment to the stomach, as above referred to.

The anastomosis, including its immediate pathology, having been cut away, the rest of the procedure will depend upon the presence or absence of the pylorus, and if present, its patency.

In the presence of an open pylorus and no evidence of further ulceration of the stomach it is my practice to close the opening or openings in the stomach and unite the ends of the jejunum, preferably by side-to-side anastomosis, or, if this is not possible, an end-to-end union. In the presence of obstruction of the pylorus by cicatricial contraction, close the opening in the stomach, excise the old gastroenterostomy and anastomose the proximal and distal ends of the jejunum and make either a Finney pyloroplasty or the ordinary gastroduodenostomy.

In the absence of the pylorus, due to a prior pylorectomy or subtotal gastrectomy, a new gastroenterostomy must be made either in the usual way or by Roux-Y. I now rarely make the latter, owing to the risk of another marginal ulcer forming, since the gastric juice flows directly into the distal limb of jejunum without being mixed with the bile and the pancreatic juice.

It may be of interest to mention that I have one patient upon whom I have operated three times for marginal ulcer and who now, I feel quite sure, has a fourth one. This is in keeping with what I have always maintained, that some individuals have an ulcer habit which it seems nothing will cure.

EXPERIMENTAL INTESTINAL OBSTRUCTION*

A STUDY IN SEVERED GUT OBSTRUCTION AND SEGMENTAL OBSTRUCTION

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When a number of investigators working at the same problem arrive at different conclusions, the confusion is at times ascribable to the fact that each one has worked out but a part of it. Moreover, the various findings may not have been properly interpreted and correlated, which of course often results in the presentation of divergent theories. As this would seem to be the case in connection with the experimental study of intestinal obstruction, the writer has attempted to approach the problem from this standpoint and correlate some of the widely contradictory views.

In the report here submitted, the writer has duplicated in part the work of others and also carried out a series of original experiments. Morphine-ether anæsthesia was employed in all of the operations.

In presenting the experimental data, it would seem expedient to arrange the subject matter into three groups, as follows:

Group I.—*Severed Gut Obstruction:* Observation made to show the existence of a distinct duodenal obstruction entity in which the pancreas plays the dominant rôle (Draper,[1, 12] Sweet, et al.[2]).

Group II.—*Segmental Obstruction:* Observations made to show the existence of a distinct intoxication resulting from intestinal segments or loops (Roger,[3] Whipple, et al.,[4] Murphy and Brooks,[5] Dragstedt, et al.[6]).

Group III.—An attempt to clear up certain points of discord between the various observers.

Group I.—*Severed Gut Obstruction:* The first group of investigators produced an obstruction in the duodenum by simple severance and closure of the oral and aboral ends. Following this operation the animal has a few hours of normal existence and then rather suddenly develops a group of characteristic symptoms, namely, rapid pulse, vomiting, tremors, spasticity of the hind legs, and finally prostration and death occurs within a few days. This symptom-complex is, in the main, afebrile. Autopsy reveals (outside of the experimental obstruction) congestion of the viscera (liver, spleen and kidneys) with marked congestion of the mucosa of the terminal colon and to a less degree congestion of the gastric and duodenal mucosa.

Simple severance of the gut (Fig. 1) and invagination of both ends,

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* Read before the Clinical Society of St. Bartholomew's Clinic and Hospital, New York City, December 22, 1920.

if placed just aboral to the bile and pancreatic ducts,[7] is followed by death in from thirty-six to ninety-six hours. When the obstruction is placed orally or aborally to this point (Figs. 2, 3 and 4) the length of life


FIG. 1.
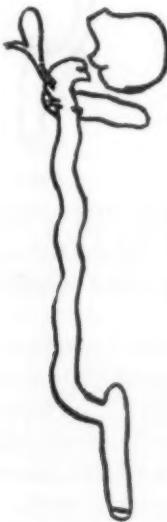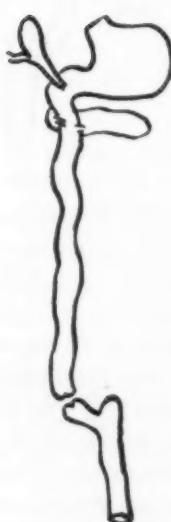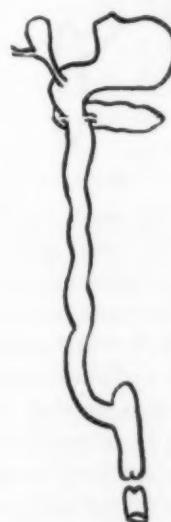
FIG. 2.   FIG. 3.   FIG. 4.

is increased and the attendant symptom-complex is changed.[8] The small amount of necrotic tissue coincident with invagination of the gut cannot be held responsible for the death of the animal, on the ground that this factor remains the same irrespective of the location of the obstruction.

These experiments show that there is a point in the duodenum at which obstruction is more lethal than at any other point in the entire bowel.

In a previous communication the writer and Doctor Draper [8] reported the result of implanting the aboral end of a duodenal transplant with its outbuds, 15 cm. in length (the oral end of which was occluded), into the ileum. At the same time the continuity of the canal was reëstablished by a gastrojejunostomy (Fig. 5). Subsequently a severed gut obstruction was made 35 cm. from the gastrojejunostomy opening, *i.e.*, oral to the site of the transplant (Fig. 6). In control animals a similar obstruction, also 35 cm. from the pylorus, was fashioned without transplantation of the duodenum and its outbuds (Fig. 7). The transplant animals lived seventeen days; the control animals lived six days. This
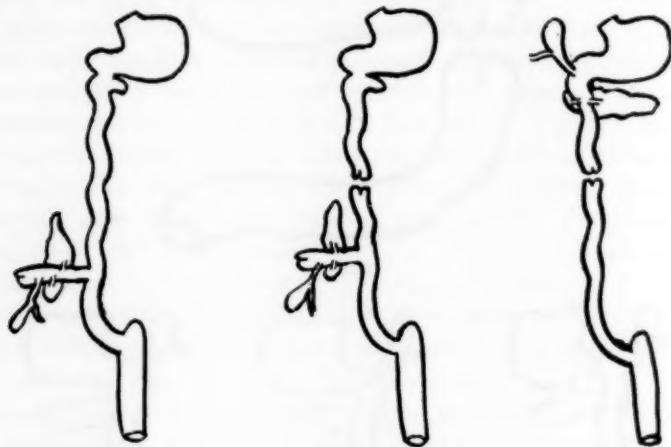
FIG. 5.　　　　　　FIG. 6.　　　　　　FIG. 7.

seventeen-day period of life is three days longer than that of an obstruction at the ileocecal sphincter (fourteen days) with the duodenum and its ducts left in their normal position. All fulminating toxic symptoms were absent in the transplant animals.

In the following experiments a 15 cm. duodenal transplant with its oral and aboral ends occluded was employed. A gastrojejunostomy was performed to establish continuity of the gut (Fig. 8). These animals died within twenty-four hours, the result of a partially distended devitalized transplant (segment). Death occurred before all the characteristic symptoms of high obstruction developed. Furthermore, if the oral end of this transplant was drained externally (Fig. 9) the animal lived for several days without exhibiting any of the signs of obstruction.

In conjunction with these experiments it was demonstrated that animals in which the entire duodenal contents were drained externally lived as long as animals obstructed in the same portion of the gut; a similar condition of affairs obtained in connection with the jejunum. However,

in both instances the attendant symptomatology was entirely different than occurred in the obstructed animals.

PROTOCOLS OF CASES (SERIES OF 1920). NUMBER OF DOGS, 9 *

Dog 126.—Large male, brown and white. Operation (Fig. 8): Gastrojejunostomy. Pyloric section—inversion oral and aboral ends; duodenal section 4 cm. below bile and pancreatic ducts, inversion oral and aboral ends. Marked
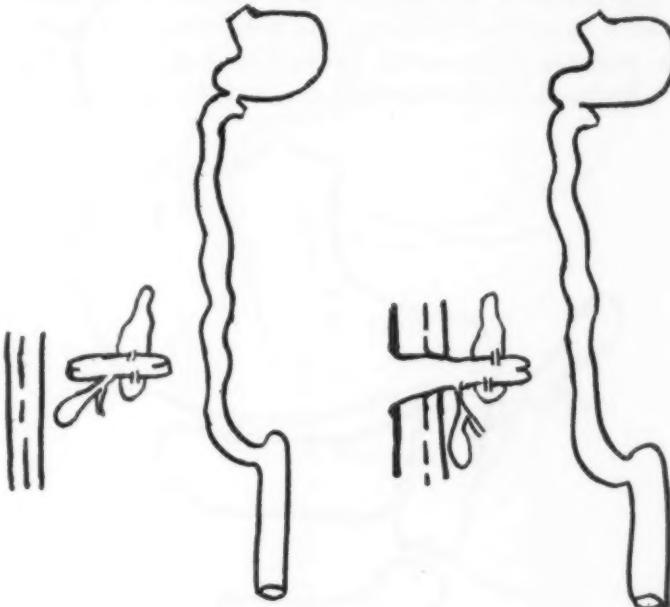

FIG. 8.   FIG. 9.

prostration followed by death within eighteen hours. Autopsy: Surgical pathology produced: partially devitalized segment, free sero-sanguinous fluid in abdomen, no peritonitis, intestinal mucosa congested throughout.

Dog 51.—Small, brown male. Operation (Fig. 9): Gastrojejunostomy. Pyloric section, inversion oral and aboral ends: duodenal section 4 cm. below pancreatic and bile ducts, oral end inverted, aboral end drawn through incision, sutured in place, left patent; animal died within seventy-eight hours. No fulminating symptoms. Post-mortem: Skin excoriation, gastrojejunostomy opening was patent, omentum wrapped around transplant, slight congestion of peritoneum at site of wound, no congestion of intestinal mucosa.

Dog 55.—Medium, black and white, hairy female. Operation: Duodenal drainage. Duodenum severed below bile and pancreatic ducts; oral end inverted, aboral end drawn through incision and sutured in place. Animal lived ninety-two hours. No fulminating symptoms; gradual increasing weakness and death. Post-mortem: Marked skin excoriation, no congestion of intestinal mucosa; stomach markedly contracted.

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* The statement " number of dogs " placed after " Protocol of Cases " throughout this presentation, refers only to the number of dogs in which it was possible to record positive findings. In each series of experiments a much larger number of dogs was used; many of these died of accidental complications and are for this reason not included in the number stated.

Dog 109A.—Small, white terrier, female. Operation: Jejunal drainage. Jejunum severed 30 cm. from duodenojejunal ligament; oral end inverted, aboral end drawn through skin incision and sutured in place. Duration of life 186 hours. Gradual weakness and death without fulminating symptoms. Post-mortem: Skin excoriated; stomach markedly contracted; slight peritoneal congestion at wound margin. No congestion of intestinal mucosa.

These experiments would seem to bear out the supposition that the duodenum with its outbuds produces the lethal toxins of high intestinal obstruction; that the gastro-toxins isolated by Roger [9] do not produce a true picture of duodenal obstruction, and that the intestinal canal does

FIG. 10.

not produce a very marked toxæmia if the duodenum and its outbuds are transplanted into the gut below the obstruction.

With regard to the toxicity of the bile in connection with severed gut obstruction, it was found that when the common bile-duct was ligated, the dog lived for several weeks. However, if the gut was obstructed below the entrance of the pancreatic ducts, and the common bile-duct was ligated with or without drainage of the gall-bladder (Figs. 10 and 11), the animal died within thirty to ninety-six hours with the characteristic symptoms of high intestinal obstruction.

PROTOCOLS OF CASES (SERIES OF 1918). NUMBER OF DOGS, 6

Dog 201.—Small male, black and white. Operation: Common bile duct ligated. Duration of life sixteen days. Autopsy: Gall-bladder distended; common duct found severed and ligated.

Dog 214.—Male, brown. Operation (Fig. 10): Common bile duct ligated. Intestine obstructed below the pancreatic and bile ducts. Symptoms characteristic of high

intestinal obstruction. Duration of life ninety-five hours. Autopsy: Gall-bladder distended; common duct ligated; liver congested (black); stomach somewhat dilated; congestion of gastric, duodenal and colon mucosa.

Dog 206.—Medium, female, brown and white. Operation (Fig. 11): Gall-

Fig. 11.
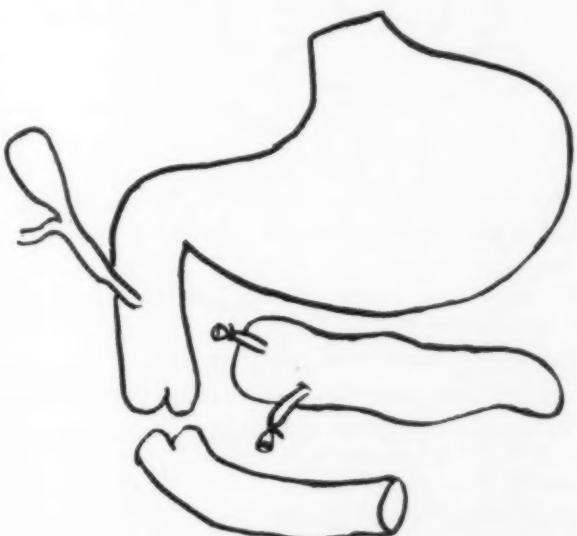
Fig. 12.

bladder drained externally; common duct ligated. Intestine obstructed below pancreatic and bile ducts. Duration of life sixty-five hours. Symptoms those of intestinal obstruction. Autopsy: Surgical pathology produced, plus that obtained in severed gut obstruction.

Meltzer and Salant [10] have shown that the normal bile from many rabbits possesses an element which will produce chronic convulsions in frogs. Roger [11] has also shown the toxicity of bile. However, in these experiments this toxicity is a negative factor.

These observations agree with those of Draper [12] who stated: " It did not matter whether the bile emptied into the oral or aboral loop near the point of obstruction; whether the duct was simply ligated or cut or whether cholecystileostomy was done, the lethal outcome appeared rather conclusively still to be dependent entirely upon the position of the obstruction."

The influence of the pancreas in severed gut obstruction was studied by ligation of both pancreatic ducts with the duodenum (Fig. 12) obstructed. Some of these animals lived five to seven days. In similar
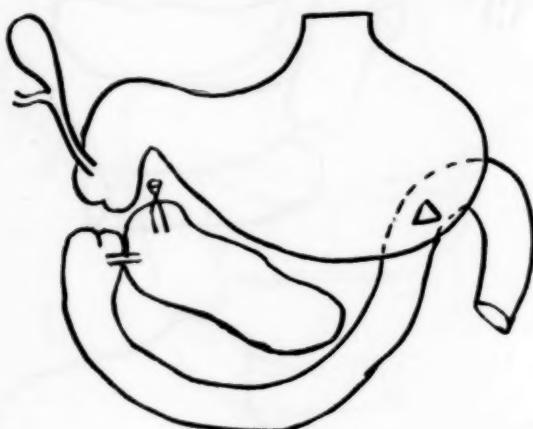

FIG. 13a.

experiments (Sweet, et al. [2]) the animals lived seven to eight days. None of these animals died with the symptoms of high intestinal obstruction.

Draper [13] performed this experiment somewhat differently, ligating the lesser pancreatic duct. The gut was obstructed above the greater pancreatic duct in some cases, and in others below it. A gastroenterostomy stoma control was added (Fig. 13a and b). If the obstruction was placed oral to the duct the animals lived during the stoma control, which was seventy-two hours; if placed below, they died during stoma control.

PROTOCOLS OF CASES (SERIES OF 1920). NUMBER OF DOGS, 3

Dog 130.—Medium, male, brown and white. Operation (Fig. 12): Ducts ligated. Obstruction placed below pancreatic and bile ducts. Animal died 164 hours later without signs of high duodenal obstruction. Autopsy: Surgical pathology; very slight congestion of gastric and colon mucosa; omentum adherent to pancreas.

In another set of experiments Sweet, et al., [2] isolated an ileal segment, restored the continuity of the gut, and, in some cases, filled the segment

or loop with pancreatic juice, and in others with fresh dog's pancreas. A number of these animals died within the time limit of high intestinal obstruction with its characteristic symptoms. Roger and Garnier [14] have demonstrated the toxicity of pancreatic juice, and also that this is increased when mixed with intestinal juice. Davis and Stone [15] have shown that duodenal secretion from which the pancreatic juice is excluded is not toxic as long as it is kept from bacterial decomposition. Moorhead and Landes,[16] Mann and Kawamura,[17] as well as Dragstedt, et al.,[18] have demonstrated that duodenectomy is compatible with life and perfect health for short periods of time at least.

Our experiments and the observations recorded above suggest that the pancreas plays an important rôle in high severed gut obstruction.
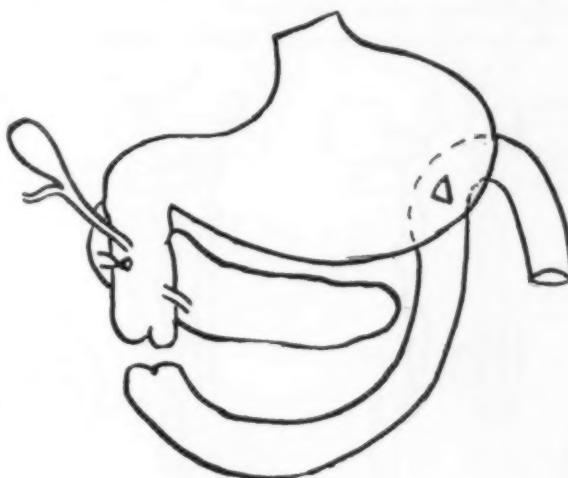

FIG. 13b.

This would also seem to show that the duodenal mucosa is not the determining toxic factor and that this membrane is not essential to life.

Sweet, et al.,[2] states: " . . . the explanation of the similarity between acute pancreatitis and acute high obstruction—they are alike because they are both essentially the same thing, an intoxication with the toxic products of protein cleavage, in pancreatitis certainly due to proteolytic ferments of the pancreas, in high obstruction not necessarily, perhaps, but in our opinion in all probability, the same toxin, produced by the same ferment. In pancreatitis the escape of the products of digestion of the pancreas into the tissues permits the intoxication; in obstruction, the conditions of obstruction permit the absorption of the toxic products, which under normal conditions would either not be formed, or if formed would be immediately broken down to nontoxic products."

GROUP II.—*Segmental Obstruction:* The second group of investigators produced a doubly occluded segment or loop, in some cases using a gas-

troenterostomy to drain the duodenum, in others reconstructing the gut; while in still others the continuity of the gut was interrupted, a tape being employed to isolate a segment or loop.

The life of the animal and the rapidity of the onset and the severity of the symptoms in this type of obstruction depend upon several factors: the size of the segment; the condition of its circulation, whether this is partly or completely occluded; the location of the segment and the consequent variations in the digestive activity of the mucosal cells; and the bacterial content of the segment. Death results within from three hours to three days. The fatal outcome is preceded by listlessness, "groggyness," rapid pulse, vomiting and rise of temperature; the last may become subnormal. In the very toxic cases the animal at once becomes markedly prostrated and soon dies.

Necropsy shows the experimental lesion consisting of a segment of
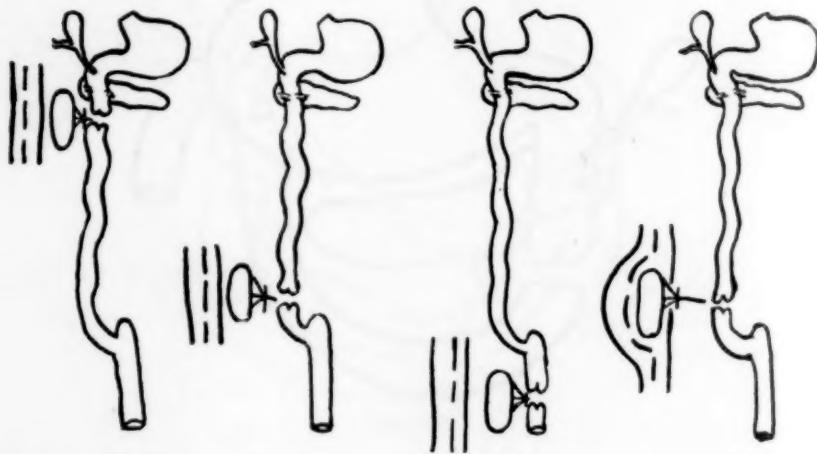
FIG. 14.   FIG. 15.   FIG. 16.   FIG. 17.

gut in different degrees of devitalization; free sero-sanguinous fluid in the peritoneal cavity; the engorgement of the liver, spleen and kidneys; congestion of the mucosa of the stomach, of the small intestine and, to a lesser degree, of the large intestine.

In the following series of experiments an excluded, bilaterally occluded segment about 20 cm. in length was used, the oral and aboral ends of the gut contiguous to the segment were inverted and closed. The circulation both to and from the segment was deligated, thus immediately devitalizing it. In each instance it was demonstrated that the experimental segment contained a colon-like bacillus. This exact procedure was carried out in the duodenojejunum (Fig. 14); in the ileum, 8 cm. oral to the ileocecal sphincter (Fig. 15), and in the colon region about 8 cm. oral to the anus (Fig. 16). All these segments were left within the peritoneal cavity.

In other animals ileal segments were placed between the fascial planes

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of the abdominal wall (Fig. 17), and in still others the segment was placed exterior to the skin (Fig. 18).

All the animals died within seventy-two hours except those in which the segment was placed externally to the skin, in the latter event the segment had no effect on the health of the animal. Of the intraperitoneal segments, those fashioned from the duodenum were the most toxic, death occurring within twenty and one-half hours; those derived from the ileum were fatal in twenty-three to twenty-four hours, and those from the colon died in thirty-five to seventy-two hours. In the fascial segments located between the planes death occurred within twenty-six hours.

Since the dogs in Group II, just described, also had an associated severed gut obstruction (refer to Figs. 14, 15, 16, 17 and 18) oral to the
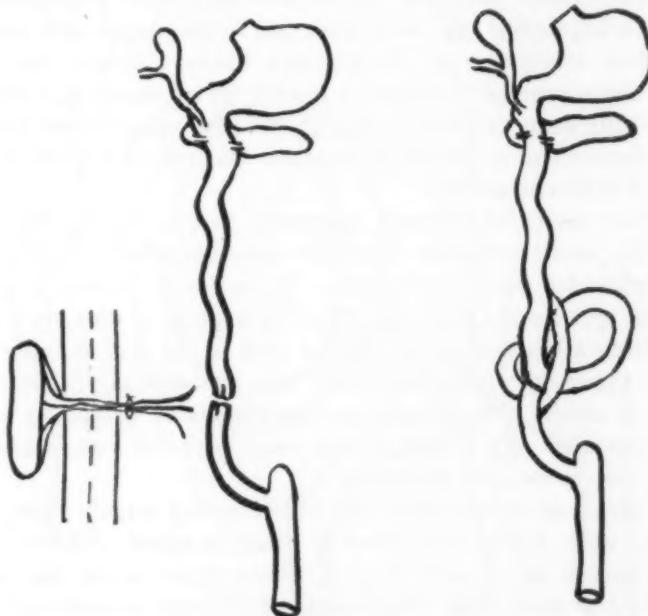

FIG. 18.   FIG. 19.

excluded segment, it is important to consider the significance of this in relation to the segmental type of obstruction.

None of these animals presented a typical picture of high severed gut obstruction, although the actual mechanical obstruction existed. The exception to this was noted when the obstruction existed in the duodenum (where the severed gut obstruction is most toxic), in which event some of the animals exhibited slight spasticity of the hind legs. It has been shown that in high severed gut obstruction most of the animals have a symptomless period of from eighteen to twenty-four hours in which they appear normal; while those animals with a devitalized segment become toxic and prostrated within this period and die within twenty-six hours, excepting when the segment is derived from the colon.

Excluding the confusing elements which arise in connection with a segmental obstruction in the duodenum where the two types are more or less associated, let us compare the length of life and symptoms of a simple severed obstruction in the ileum with those in connection with the isolation of an ileal segment. In the former instance the animal lives about fourteen days with signs of emaciation and gradual weakness until death intervenes and no fulminating symptoms develop, while in the latter instance (segmental obstruction) the animal dies within twenty-four hours with only a few hours of freedom from symptoms; this period is promptly followed by listlessness, unsteady gait (not spastic), marked weakness, and finally prostration and death.

When a severed gut obstruction is produced at the rectum the same picture develops as in the ileum, except that the animal lives twenty-eight days, while a segmental type of obstruction in this location is followed by death in from thirty-five to seventy-two hours. Hence, the ileal and rectal segments represent almost a pure type of segmental obstruction and present the same picture as though the continuity of the bowel were restored. Surely this would seem to show that the two types of obstruction are of a different nature.

In another series of animals segments 30 cm. to almost the whole length of the small intestine from the duodenojejunal ligament to the ileocecal sphincter were employed. These loops * were produced by knotting the gut itself (Fig. 19); by simple twist of the gut (Fig. 20); and by pulling a loop of gut through a rent in the mesocolon (Fig. 21). In some of these cases the circulation was immediately occluded (knotting) and in others the circulatory nutrition was gradually interfered with by peristalsis and filling of the loop with its own secretion and transudate, and consequent distention.

In this series of observations the animals died within three to forty-two hours, with symptoms varying from marked prostration, from which the animal never recovered, to those observed in the segmental experiments just described. The length of life and severity of the symptoms in these loop cases apparently did not depend so much upon the size of the loop as upon interference with the blood supply to the loop and its location. In the large loops where the circulation was immediately cut off death occurred within from three to seven hours. In the instance in which the gut was drawn through the rent in the mesocolon with the gradual occlusion of the circulation, the animal lived forty-two hours despite the fact that the loop was 80 cm. in length.

In the following experiments a segment of gut in the duodenojejunum was isolated without deliberate interference with its circulation. In

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* The term "segment" is used to denote an arrangement of gut as shown in Fig. 15; the term "loop" is used to designate the condition of affairs shown in Fig. 21.

some cases the continuity of the gut was restored (Fig. 24, a and b). In other cases the ends were inverted or a segment isolated with tape (Figs. 22, a and b; 23, a and b), whereupon a functional or severed gut obstruction was established above the point of isolation of the segment. In the dogs in which the continuity of the gut was not reëstablished and no
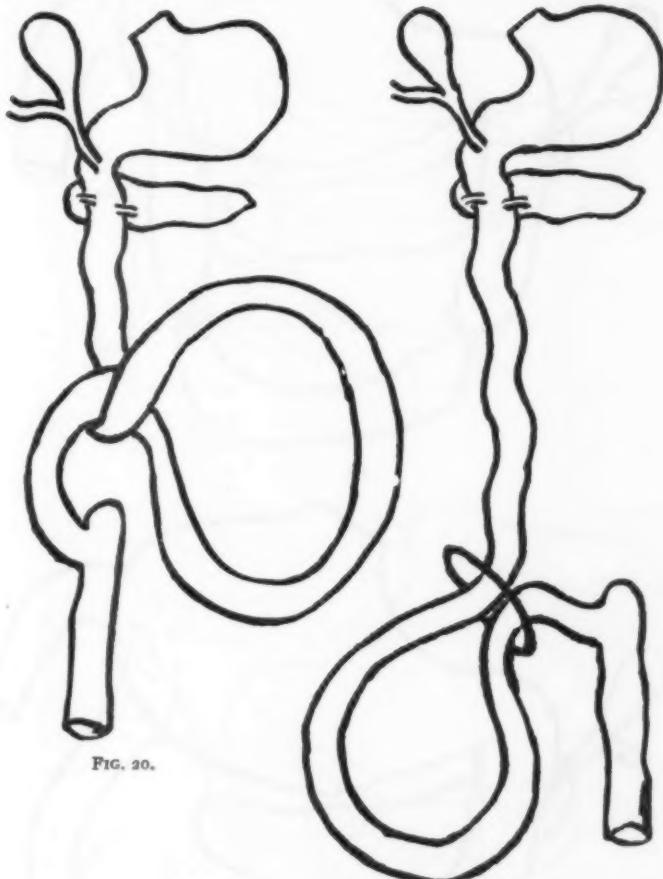

FIG. 20.

FIG. 21.

spontaneous distention of the segment occurred (Figs. 22, a, and 23, a) death followed within sixty hours. In those cases the segment appeared perfectly normal, showing no evidence of devitalization: that is to say, the death of the animal was the outcome of the existing severed gut obstruction. On the other hand, if under the same conditions the segment became spontaneously distended and later hemorrhagic in color, and finally devitalized (Figs. 22b and 23b), death occurred within from twenty-four to thirty-six hours. Here a combination of the severed

gut obstruction and segmental obstruction was responsible for the death of the animal, the latter (segmental obstruction) being the dominant one.
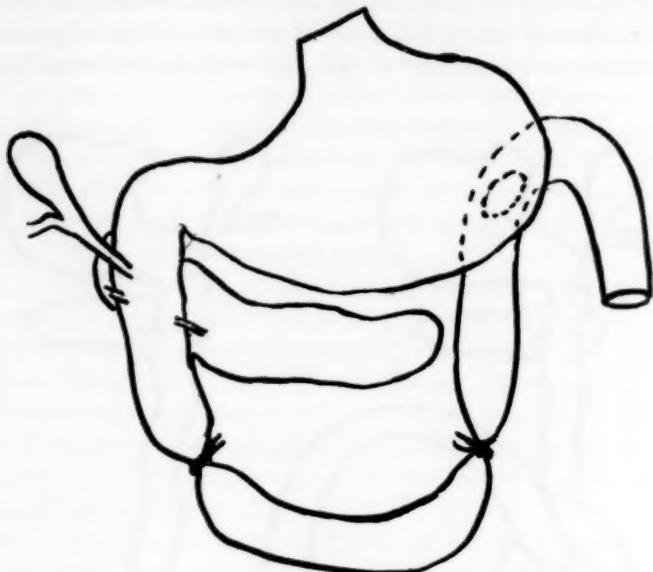
FIG. 22a.

FIG. 22b.

In those cases in which reconstruction of the bowel was practiced (Fig. 24, a) and no devitalization of the loop occurred, the animals lived several weeks. However, if the segment (Fig. 24, b) became devital-
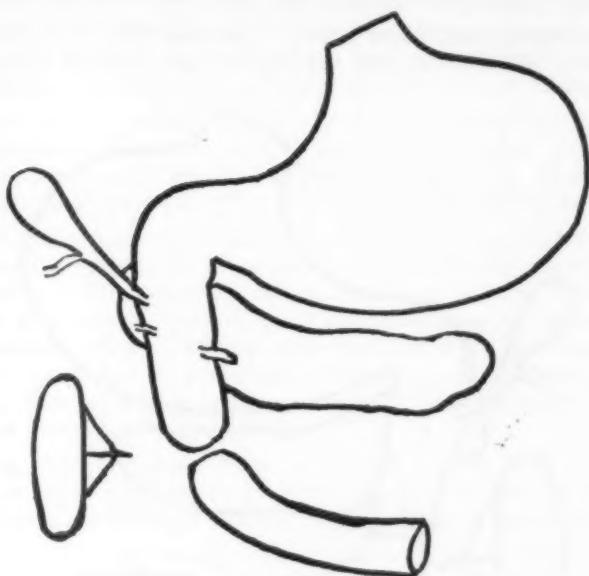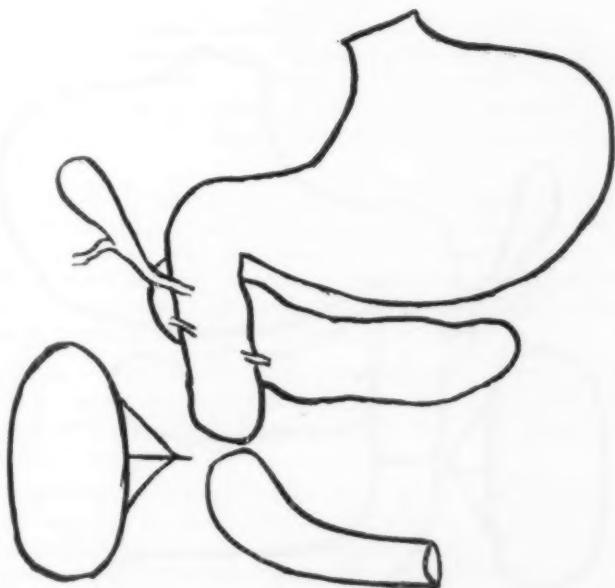
FIG. 23a.

FIG. 23b.

ized and was not removed the animal died within forty-eight hours; the death in this case being due to causes arising in connection with the segment itself, as no severed gut obstruction existed above.

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Dog 108.—Female, small, white terrier. Operation (Fig. 14): Duodenal devitalized segment. Duration of life was twenty and one-half hours. Autopsy:


FIG. 24a.
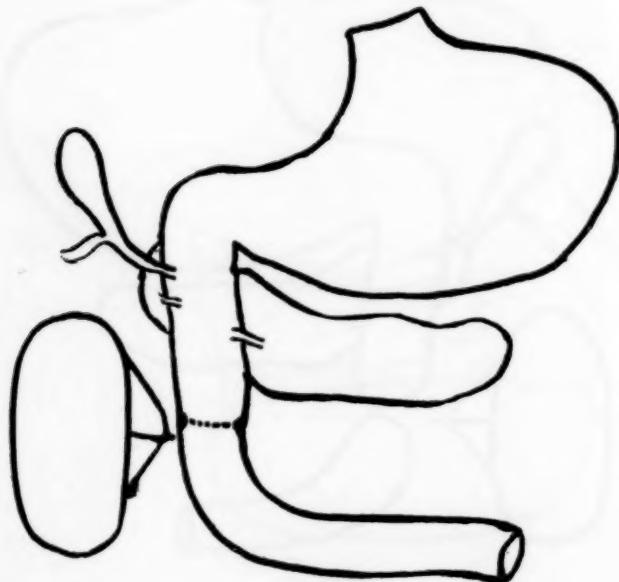
FIG. 24b.

Free sero-sanguinous in peritoneal cavity; 20 cm. of devitalized partially distended segment; no reconstruction. Congestion of intestinal mucosa small gut; slight congestion of colon; engorgement of liver and spleen.

Dog 106A.—Male, small brown, short-haired. Operation (Fig. 15) : Ileal devitalized segment. Duration of life was twenty-three hours. Autopsy: As in dog 108, with the following exceptions; Ileal segment employed instead of a duodenal segment, and that the intestinal congestion was not so marked.

Dog 133.—Female, medium, brown and white. Operation (Fig. 16): Colon devitalized segment. Duration of life was seventy hours. Autopsy: Colon devitalized segment; some free fluid in peritoneal cavity, less than in other segments; congestion of intestinal canal was less than in small intestinal segments.

Dog 87.—Male, small, black and brown, short-haired. Operation (Fig. 17): Ileal devitalized segment placed under the skin between superficial and deep fascia. Duration of life, twenty-six hours. Autopsy: No free fluid in abdominal cavity; slight congestion in parts of small intestines, none of duodenum or colon; abdominal parietes infiltrated with a sero-sanguinous fluid as occurs in the peritoneal cavity containing a devitalized segment; a segment was found in the fascial planes, from which a colon-like bacillus and a staphylococcus were isolated. The latter was probably a contamination.

Dog 109A.—Female, small white terrier. Operation (Fig. 18): Ileal segment exterior to skin; segment removed twenty-four hours later, gut reconstructed; no toxic symptoms developed. Animal made an uneventful recovery.

Dog 86.—Male, small, brown, short-haired. Operation (Fig. 19): Ileal loop 50 cm. in length knotted. Duration of life, ten to twelve hours. Autopsy: Surgical pathology produced (50 cm. devitalized loop); free sero-sanguinous fluid in peritoneal cavity. Marked congestion of stomach, duodenum, small intestine and colon.

Dog 101.—Male, medium, brindle mongrel. Operation (Fig. 20): Entire small gut accidentally twisted while forming an ileal segment. Duration of life three hours and three minutes. Autopsy: Gut twisted from duodenojejunal ligament to terminal ileum, marked dilatation and congestion; ileal segment devitalized; colon showed a slight congestion; free sero-sanguinous fluid in peritoneal cavity.

Dog 88.—Male, large, short-haired bull terrier. Operation (Fig. 21): Ileal segment removed (previous operation) and a rent in mesentery produced through which 80 cm. of small gut slid. Duration of life, forty-two hours. Autopsy: 80 cm. strangulated small intestine; gradual devitalization which accounts for the longer duration of life; free fluid in peritoneal cavity; slight congestion of the rest of the small intestine and slight congestion of colon.

Dog 53.—Male, small, brown and white terrier. Operation: Jejunal ileal segment 96 cm. in length; circulation ligated. Duration of life, six hours. Autopsy: 96 cm. partially distended, devitalized segment; free fluid in peritoneal cavity; congestion of small gut and colon.

Dog 256.—Female, medium, brown and white. Operation (Fig. 22, a): Duodenojejunal segment 40 cm. in length; tape used to isolate segment; no interference to the circulation; posterior gastrojejunostomy. Duration of life, ninety hours. Symptoms of severed gut obstruction. Autopsy: No free fluid in peritoneal cavity; surgical pathology produced; segment not distended nor discolored, contained small amount of whitish pasty substance. Gastric, duodenal and terminal colon mucosa congested.

Dog 240.—Male, small, brown. Operation (Fig. 22, b): Segment 40 cm. in length; tape used to isolate segment; no interference to the circulation; posterior gastrojejunostomy. Duration of life, seventy-four hours. Symptoms of severed

gut and segmental obstruction. Autopsy: Surgical pathology produced, segment black in color, markedly distended; congestion of gastric mucosa, small and large intestinal mucosa; free fluid in peritoneal cavity.

Dog 303.—Male, large, white. Operation (Fig. 23, a): Segment 40 cm. in length; no interference to the circulation; no reconstruction of the gut. Symptoms of severed gut obstruction. Duration of life, forty-eight hours. Autopsy: Surgical pathology produced; no distention of segment; no free fluid in peritoneal cavity; congestion of duodenal, gastric and colon mucosa.

Dog 309.—Male, large, black. Operation (Fig. 23, b): Segment 30 cm. in length; no interference to the circulation; no reconstruction of the gut. Duration of life, thirty-six hours. Symptoms of severed gut and segmental obstruction. Autopsy: Surgical pathology produced; segment distended, dark hemorrhagic in color; free fluid in peritoneal cavity; no observation on congestion of intestinal mucosa made.

Dog 291.—Female, medium, black and white. Operation (Fig. 24, a): Jejunal segment 40 cm. in length; no interference to the circulation; reconstruction of bowel; end-to-end anastomosis. Dog made an uneventful recovery. Two weeks later, dog sacrificed, chloroform anæsthesia; blood removed for chemical study. Autopsy: Segments normal in appearance, not distended; omentum wrapped around segments; anastomosis in good condition; no intestinal congestion.

Dog 278.—Female, large, black and white. Operation (Fig. 24, b): Duodeno-jejunal segment 50 cm. in length; no interference to circulation; reconstruction of bowel; lateral anastomosis. Symptoms of segmental obstruction. Duration of life, fifty-six hours. Autopsy: Surgical pathology produced; segment distended; free fluid in peritoneal cavity; slight congestion gastric, small and large intestine mucosa.

These experiments definitely show that the changes in isolated devitalized segments are responsible for the lethal outcome.

In some instances when duodenojejunal segments were isolated and the circulation was not interfered with and the continuity of the gut restored, the segments did not distend nor become devitalized and the animals did not develop untoward symptoms, while, on the other hand, in a certain number of animals in which the conditions were in every regard similar to those just stated, the segment did become distended and devitalized and the animals presented the picture of segmental obstruction and soon died. When the same conditions were produced in the ileum and colon, the result in by far the greater number of cases was similar to what occurred in the duodenojejunum when no devitalization was present.

The reason why isolated segments (continuity of the gut restored) of the small intestine, especially those located in the duodenojejunum, frequently distend and become devitalized even though the circulation is not deliberately interfered with, whereas those in the colon become distended but not devitalized, is because of the preponderance of the secretory over the absorption phase in the small intestine, while the reverse obtains in the colon. Attention was called to this fact by Obalinski.[19] Although the colon segments were practically empty at the

time of their isolation, they later became filled with material, much distended and the intestinal wall hypertrophied. This was observed by Blake and Brown.[20] However, in the small intestinal segments the secretion appeared more rapidly and the distention interfered with the circulation before a compensatory state had time to develop.

This explanation cannot be applied to those instances in which the isolated duodenojejunal segment does not become devitalized, for the reason that were interference with the circulation necessarily the outcome of the domination of the secretory phase and consequent distention and devitalization, this would occur in every instance, while such is not the case. Therefore, it is necessary to search for another factor as causative in this connection.

It is suggested that the greater motility of an isolated segment of small intestine renders it more responsive to peristalsis, and thus a comparatively slight torsion of its mesenteric attachment may partially interfere with the circulation (circulatory stasis), and this in turn becomes responsible for a rapid filling of the segment with a bloody transudate and intestinal secretion. If this be true, the conditions may be regarded as important factors in the devitalization of isolated segment in which there has not been a deliberate interference with the circulation.

This conception (based on the observation in Groups I and II) argues that bacteria are not the all-important factor in the cause of death in experimental obstruction. Certainly in the severed gut type they appear to play no part; the only pabulum is the devitalized tissue at the site of inversion, and if this small amount of necrotic tissue were sufficient to cause death the symptom-complex of obstruction in the duodenum and colon regions would be the same. Instead of this, there is a difference of about twenty days between colon and duodenum (severed gut obstruction) in duration of life.

In the second group of observations, the segmental obstruction is compatible with life if the continuity of the gut be restored and if there is no devitalization of tissue, although bacteria are present in the segment.

However, when devitalization of tissue occurs there is a pabulum for bacteria and the production of toxic substances must follow.

When death occurs early (three to seven hours) after a large loop or segment has been isolated and its circulation abolished, one must search for some other cause for death than the action of bacteria upon devitalized tissue. It is, therefore, submitted that the specialization of the digestive cell, which is greatest in the duodenojejunum, is the foremost lethal factor, while the action of bacteria is a secondary one in segments devitalized by immediate interference with the circulation. However, it is not improbable that in gradually devitalized segments (the outcome of distention and circulatory stasis) bacterial action is the important pernicious factor because of the period of incubation thus presented.

From an experimental standpoint, putrefaction, the outcome of bac-

terial action upon nitrogenous foodstuffs, may be disregarded on the ground that the entire complex stated above may obtain in fasting animals. The toxicity of segmental obstruction may be increased if food is present in the segment, but this may be regarded as a minor factor. This view is supported by the fact that a simple severed gut obstruction at the rectum permits the animal weeks of life without the appearance of fulminating symptoms, and surely putrefaction must be very active under these conditions.

To summarize with regard to Group II (segmental obstruction): The evidence at hand suggests that the toxic products of protein cleavage may be a primary cause of death and that these cleavage products are the result of proteolytic action on somatic cells the death of which is the outcome of interference with their blood supply. The action of bacteria on devitalized tissue is no doubt of secondary importance. However, they must become a prominent factor when the circulation is gradually occluded. As the investigation of the activities of intestinal anaërobic bacteria is still without definite result, the future may show that bacteria are more of a factor in segmental obstruction than now seems to be the case.

GROUP III.—An attempt to clear up certain points of discord between the various observers.

Of the many observers working with intestinal segments or loops almost all, except Draper [8] and Sweet [2] and his co-workers, have disregarded the importance of the simultaneous presence of the severed gut obstruction (functional obstruction) oral to the isolated segment. To Sweet [2] belongs the credit of demonstrating the importance of the pancreas in simple severed gut obstruction.

Roger [21] was one of the early observers to study this intricate problem of intestinal obstruction from a chemical and toxicological standpoint. He and his associates, notably Garnier, isolated the toxins (including toxic proteoses) from the different portions of the intestinal canal. They studied the toxicity of the stomach contents, of the bile, and of the pancreatic juice. They demonstrated that the toxins derived from the intestinal mucosa are more toxic than those extracted from the contents of the gut, and that the duodenal mucosa possesses a greater toxicity than that of the ileum. Their bacteriological studies encompassed the aërobic and the anaërobic groups.

Viewing the experimental work just mentioned as a whole, one gets the impression that the isolation of a single lethal, toxic agent in both the types of obstruction under consideration is impossible, and that a number of substances must be taken into account in animals whose condition is normal except for the experimental obstruction. While this may be true, our experimental work seems to establish a relative lethal importance as far as these various factors are concerned.

Whipple [4] and his co-workers studied the loop or segmental type of

obstruction, and their isolation of a toxic proteose was considered the lethal agent. That this proteose is composed of one or more primary proteoses and perhaps some B-nucleoprotein and nucleohiston is a later view toward which Whipple [22] seems to lean.

However, Whipple's contention that the toxæmia is the outcome of a perversion of secretion or of a pernicious activity of the mucosa is difficult to understand, unless one assumes that the perversion of secretion may be the result of circulatory disturbances despite the fact that the blood supply of the segment is not deliberately interfered with. This
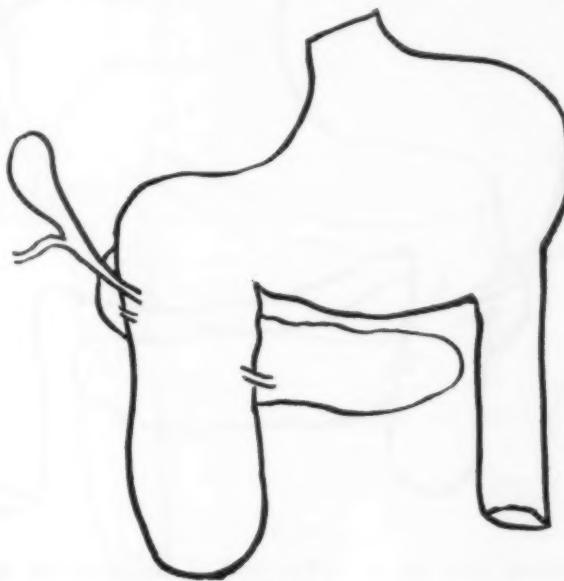

FIG. 25.

is borne out by the observation that the presence of segments in which no circulatory changes have occurred is compatible with life provided the continuity of the gut is restored.

With regard to the experiments of Whipple, *et al.*,[4] in which the animals died, and autopsy showed only the loop of intestine which contained a certain amount of pasty material and no histological evidence of injury to the mucosa; Sweet, *et al.*,[2] called attention to the fact that in these animals a functional obstruction (severed gut type) existed oral to the segment (Fig. 22, a) and that the simultaneous presence of a gastro-enterostomy did not necessarily drain the duodenum above the obstruction. Sweet and his co-workers proved this experimentally. That is, they showed that the duodenum was drained by a gastroenterostomy only when the duodenum dilated and became hypertrophied (Fig. 25); under these conditions the animal survived. On the other hand, if the duodenum did not undergo the changes stated above, the gastroenterostomy was not effective as an oral drain (Fig. 26) and the animal died.

A similar explanation of the fatal outcome is applicable to the experiments (Fig. 27) of Whipple, *et al.*, in which, although the segment was drained externally and even freely washed out, the animals died because the oral gut was not drained by the gastroenterostomy. In addition to this, Sweet and his coworkers further proved the rationale of their contention when they isolated a segment of the duodenum (similar to that of Whipple, *et al.*) but restored the continuity of the gut and at the same
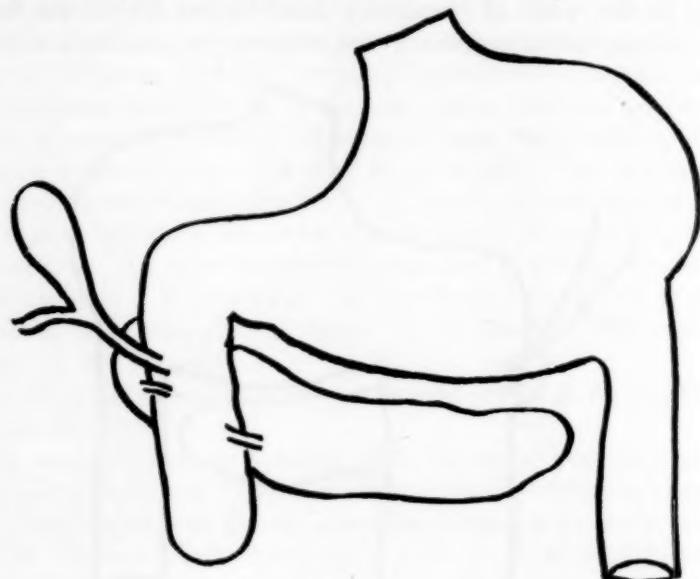
FIG. 26.

time demonstrated that when either end of the isolated segment was drained the animal remained normal. This operation really consists in establishing a Thiry-Vella fistula (unilateral occluded segment).

Draper,[7] after experimenting with Thiry-Vella fistulæ, observed that at the end of four or five days the animals showed marked evidence of toxæmia, rapidly lost weight and died within a short period of time. However, when the mucosa was removed from the isolated segment none of the symptoms stated developed. These findings would seem to accord with those of Whipple, *et al.*

The observations of the writer in connection with Thiry-Vella fistula would seem to justify acceptance of the views of Sweet.

PROTOCOLS OF EXPERIMENTS (SERIES OF 1916–1917). NUMBER OF DOGS, 3

Dog 167.—Female, small fox terrier. Operation March 12, 1917; Thiry-Vella fistula. Animal died June 17, 1917. Duration of life, ninety-seven days. No fulminating toxic symptoms developed. Animal became gradually emaciated. Autopsy: Negative as to actual cause of death.

In this series of experiments death occurred rapidly in three instances; the fatal outcome, however, was due to the presence of a de-

vitalized segment (unilateral occlusion), to peritonitis and to a pancreatic abscess and was not the result of a toxæmia sequential to the absorption from the duodenal segment (unilateral occlusion).

Certainly if a toxæmia is produced it is not a pernicious factor as compared to the effects of either of the obstructions under consideration. The rapid death in Whipple's experiment (Fig. 27) must be
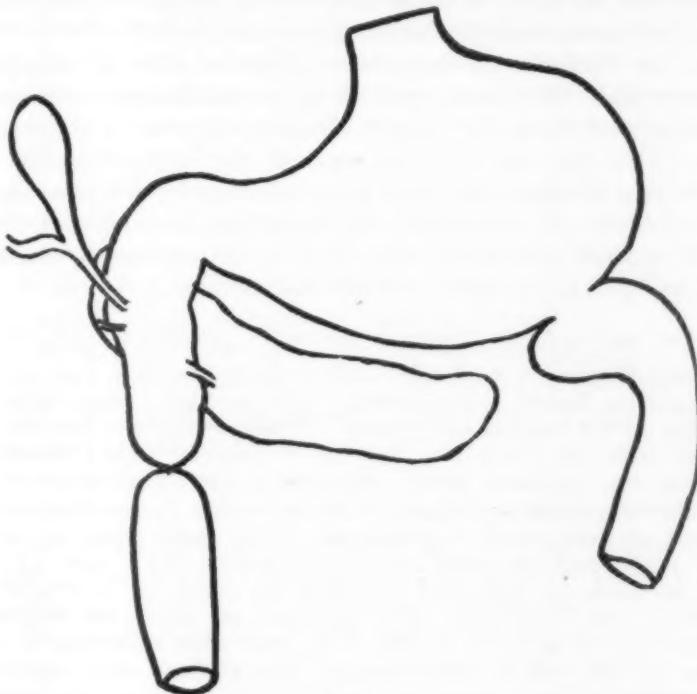
Fig. 27.

attributed, as Sweet suggested, to the oral functional obstruction (severed gut obstruction).

The view advanced by Sweet, *et al.*,[2] which Draper [8] and his associates at one time were inclined to accept, that when a segmental obstruction was fashioned, the proteose of Whipple was formed in the gut above (Figs. 22, b; 23, b) the point of obstruction and excreted into this segment, cannot be reconciled to the fact that in the presence of a segmental obstruction in which the continuity of the gut was restored (Fig. 24, b) and the animal died. However, if the isolated segment was not devitalized (Fig. 24, a) the animal lived. This argues that the lethal toxin is formed in the segment and is not the result of the oral obstruction, for the reason that the obstruction element is removed from the problem by restoration of the continuity of the gut. This is one of the determining considerations in support of the belief that Whipple's entity is not the outcome of an oral functional obstruction.

The fact previously reported,[8] into which the contents of isolated segments (with reconstruction of the continuity of the gut) was injected showed only slight or no evidence of intoxication, can only be explained on the ground that we committed a technical error in the isolation of the poison. Our conception at that time was that since no functional obstruction existed above the segment, no poison was formed. However, since this time we have on frequent occasions isolated a proteose under the very conditions under which we previously failed.

As to the character of the proteose from a chemical standpoint, it would seem that the poison consists of several further split products. This is supported by the fact that in chemistry a proteose is not regarded as toxic. This does not, however, exclude the conception that the intoxication may be dependent upon the product of further cleavage of the protein molecule. In any event, one must bear in mind that the intravenous injection of the poison or poisons is followed not by the signs of high severed gut, but of segmental gut obstruction.

PROTOCOLS OF CASES (SERIES OF 1916–1917). NUMBER OF DOGS, 10

Dog 221.—Female brindle, 6 kilos. 6/8/17—Ether anæsthesia 8.40 P.M. Kymograph observation throughout experiment. 8.45 P.M.—Blood pressure normal. Injection of 35 c.c. purified loop fluid (lethal dose). Primary rise of blood pressure—duration ten minutes. 9.50 P.M.—Pulse, 120, slight fall in pressure. 9.58—Temperature, 100. 10.00—Pulse, 114, semi-solid stool. Pressure normal. 10.25—Semi-solid stool. 10.45—Pulse 126, irregular diarrhœa. Pressure normal. 10.50—Temperature, 98. 11.15—Small semi-solid stool. 11.30—Respiration, 14; temperature, 94; pulse, 104, irregular. 11.45—Small semi-solid stool. 12.15—Bloody stool. 1.00 A.M.—Bloody stool. Temperature, 96; respiration, 16; pulse, 62; slight fall in pressure. 1.45—Bloody stool. 2.40—Temperature, 96.5; respiration, 20; pulse, 100, irregular. Still farther fall in blood pressure. Bloody stool. 3.30—Pulse imperceptible; profound prostration. Marked fall in blood pressure. 5.10—Animal dead. 5.30—Autopsy: Slight congestion of liver, spleen, and more or less throughout the stomach and intestinal mucosa. Colon contents blood tinged.

Dog 222.—Male, black and white. 6 kilos. 6/8/17—Ether anæsthesia 9.30 P.M., pulse, 100. 9.35—Intravenous injection 130 c.c. purified loop fluid (lethal dose). Compare with dog 221. 9.40—Pulse, 36; respiration, 18. Dog still under influence of ether. 10.00—Dog responds to whistle and call, staggers around. 10.10—Pulse, 60. 10.30—Animal became prostrate. Pulse, 186; temperature, 98. 10.55—Liquid and semi-solid stools. Profound prostration. 11.05—Diarrhœa. Animal attempts to walk around; urinates. 11.15—Bloody stools (diarrhœa). Prostration less. 11.35—Pulse, 132; respiration, 18; temperature, 97. Small watery stool. 11.50—Dog very weak; falls to floor when placed on feet. Small bloody stool. 12.40—Watery stool. Marked prostration. 1.00 A.M.—Diarrhœa. Pulse, 160; respiration, 15. Marked prostration. 1.30—Dog cold. 2.00—Pulse, 120. 2.10—Pulse, 150. 2.15—Pulse, 220. 2.20—Animal dead. Duration of life four hours and fifty minutes. 3.00—Autopsy: Same as dog 221, except for marked engorgement of liver and spleen. The congestion of stomach and intestine was much greater. Dog did not vomit.

Dog 223.—Male, large, brown. 10.45 P.M.—Ether anæsthesia. Preoperative pulse, 72; respiration, 25; temperature, 101. 10.50—Injection 115 c.c. mucosa extract de albuminized. After anæsthesia slight diarrhœa. No prostration. Animal recovered at once from anæsthesia and ran around. 11.00—Pulse, 186. 11.15—

Resting. 11.40—Pulse, 72; respiration, 44; temperature, 99. Animal showed slight weakness. 1.00 A.M.—Pulse, 60; respiration, 26; temperature, 100. Weakness of hind legs. 1.30—Watery stool; no blood. 2.05—Hind legs still weaker. 2.30—Hind legs much stronger. 3.00—Pulse, 60; respiration, 26; temperature, 100. Dog in good condition. 3.10—Dog in good condition.

Murphy and Brooks [5] suggested that in intestinal obstruction the presence of necrosis of the gut, together with the action of bacteria, were the important causative factors in the toxæmia attendant upon this condition.

Dragstedt [6] and his associates, working along similar lines, were inclined to regard bacterial action as the dominant factor in the production of the toxæmia. They claim that the presence of sterile devitalized loops is compatible with life.

The fact that the presence of sterile devitalized segments of gut is not followed by death, does not answer the contention on part of the writer that duodenal segments are more toxic than those fashioned in the colon, nor does it make less true the fact that the isolation of large devitalized segments is rapidly fatal. The writer feels that though an abacterial segment is isolated in the abdominal cavity of the experimental animal, it is still capable of causing death because of liberation of a toxin the result of the breaking down of the host protein. This would explain why a duodenal segment is more toxic than one of the colon, on the ground that the digestive specialization of the cells of the mucosa is greater in the duodenum than it is in the colon; it also explains the rapid death when large devitalized segments are obstructed, as this means destruction of a greater area of cells. One of the possible fallacies of the explanation just offered might be developed in connection with further investigation of the action of anaërobic bacteria and their symbiosis with the aërobes acting on devitalized tissue. In this event, however, one would have to assume a degree of virulence on part of this combination of bacterial life not as yet demonstrated.

Further support of the non-bacterial character of the intoxication in segmental obstruction is supplied by Cooke and Whipple,[23] who produced a sterile abscess by means of turpentine injections, and acute pancreatitis by the injection of sterile bile. The advent of these conditions was followed by an intoxication very similar to that following an injection of a toxic proteose.

In investigating along these lines, the writer scraped out the mucosa of an isolated duodenal segment, thoroughly washed it and introduced the washed scrapings into the peritoneal sac of a normal dog. Following this one of three things happened: No reaction occurred; peritonitis developed; or the animal exhibited tremor, bloody stools, vomiting and rise of temperature, i.e., a non-lethal picture of a proteose intoxication, such as follows intravenous injection, was provoked. Hence, it would seem permissible to assume that we produced a condition of affairs which was in no sense ascribable to bacterial action.

Dog 163.—Male, medium, 30 cm. caudad duodenum resected; end-to-end anastomosis. Duodenal mucosa washed thoroughly; mucosa scraped and introduced into the peritoneal cavity (homologous cells). Within thirty-six hours the dog passed bloody stools; apparent tenesmus; vomited once. Temperature, 102; pulse, 156. Urinary output increased and dog very thirsty on the following day; blood and mucus passed. Temperature, 102; pulse, 114, irregular. Slight tremors; no vomiting. Twenty-four hours later the dog made an uneventful recovery. Two weeks later the washed cells from an obstructed dog were introduced into the peritoneal cavity (Dog No. 163). Dog made an uneventful recovery without signs of obstruction. One week later washed cells from another obstructed dog were introduced into the peritoneal cavity (Dog No. 163). The dog died twenty-four hours later. Autopsy revealed a frank peritonitis.

The theory of Draper,[7] that in severed gut obstruction the administration of the scrapings of jejunal mucosa suspended in water detoxicated the poison originating in the duodenal mucosa, is now regarded as fallacious, and it would seem that the beneficial effects produced may be properly ascribed to the watery contents of the mixture employed and not to any specific effect on the part of the jejunal scrapings. Hartwell and Hoguet [24] increased the duration of life in their obstructed animals by the copious administration of water. Their point of view that dehydration of tissue is the important factor with a secondary intoxication the result of dehydration, as the cause of death in severed gut obstruction, does not appear to be in accord with present views.

COMMENT AND SUMMARY

In the types of experimental intestinal obstruction discussed above, the toxins seem to have a two-fold origin. In severed gut obstruction in the duodenal region the pancreas is probably the main source of the toxin. Bacteria are apparently not a determining factor in this type of obstruction.

In the pure segmental type of obstruction (*i.e.*, an isolated segment with the continuity of the gut restored) the damaged intestinal tissue is the deciding factor as regards lethal outcome; if no devitalized tissue is present death does not occur. In non-devitalized segments bacteria alone will not be responsible for a lethal outcome. Surely at times a devitalized segment appears to be responsible for a lethal outcome long before there has been time for bacterial action to play a part in the result. When a severed gut and segmental obstruction are present together and there is no damage to the intestinal mucosa in the segment, the lethal outcome is due to the oral severed gut obstruction and not to the undamaged segments.

In both types of obstruction the breaking down of the host protein molecule appears to be an important factor in the formation of toxic substances. Whether the actual end products in both instances are chemically allied or not has yet to be proven.

In the severed gut obstruction death appears to be essentially a

physiological one. In the devitalized segmental type this is true in the main; the added element being the presence of bacteria.

For the present the character of the toxic product in the former can only be conjectured, while in the latter the not clearly defined proteose or its split products may be regarded as the lethal agent.

In conclusion the writer wishes to express his thanks to Prof. George D. Stewart for the courtesy of the research laboratory. For the constructive criticism of this paper, the generous help of Professor Haubold and Doctor Draper was obtained. Professor Gettler gave his valuable assistance in elucidation of the chemistry of the problem. To Doctors Barber, Vejvoda, Stark and Otto the writer is indebted for their able assistance in the surgical procedures carried out in these experiments.

BIBLIOGRAPHY

[1] Draper, J. W.: Surgery, Gynecology and Obstetrics, May, 1906.
[2] Sweet, J. E.; Peet, Max M.; Hendrix, B. M.: ANNALS OF SURGERY, June, 1916, Vol. lxiii, No. 6, pp. 720–728.
[3] Roger, H.: Presse méd., Jan. 4, 1911, p. 1.
[4] Whipple, G. H.; Stone, H. B.; Bernheim, B. M.: Jour. Exper. Med.
　　　　Ibid, 1913, xvii, p. 286.
　　　　Ibid, 1914, xix, p. 307.
　　　　Ibid, 1914, xix, p. 166.
　　Whipple, G. H.; Rodenbaugh, F. H.; Kilgore, A. R.: Jour. Exper. Med., 1916, xxiii, pp. 123–135.
　　Whipple, G. H.: Jour. A. M. A., 1915, Aug. 7, 1915, lxv, pp. 476–478.
[5] Murphy, F. T., and Brooks, B.: Arch. Int. Med., 1915, xv, p. 392.
[6] Dragstedt, L. R.; Moorhead, J. J.; Burcky, F. W.: Jour. Exper. Med., 1917, xxv, p. 421.
[7] Draper, J. W.: Jour. A. M. A., Oct. 7, 1916, lxvii, pp. 1080–1082.
[8] Eisberg, H. B., and Draper, J. W.: Jour. A. M. A., Nov. 16, 1918, lxxi, pp. 1634–1635.
[9] Roger, H.: Nouveau Traité de Path. Générale, Tome ii, Ext., p. 226.
[10] Meltzer and Salant.: Jour. Exper. Med., 1906, viii, p. 159.
[11] Roger, H.: La Presse méd., 27 mars, 1912.
[12] Draper, J. W.: Amer. Jour. Med. Sci., May, 1909.
[13] Draper, J. W.: Jour. A. M. A., Jan. 1, 1910, liv, pp. 5–9.
[14] Roger and Garnier: Soc. de biologie, 4, avril, 1908.
[15] Davis and Stone: Jour. Exper. Med., 1917, xxvi, p. 687.
[16] Moorhead, J. J., and Landes, H. E.: Jour. A. M. A., 1919, lxxii, p. 1127.
[17] Mann, F. C., and Kawamura, K.: Jour. A. M. A., 1919, lxxiii, p. 879.
[18] Dragstedt, C. A.; Dragstedt, L. R.; McClintock, J. T.; Chase, C. S.: Amer. Jour. Physiol., 1918, lxvi, p. 584.
[19] Obalinski: Central. f. Chir., bd. 22, s. 129.
[20] Blake, J. A., and Brown, R. M.: ANNALS OF SURGERY, Oct., 1907.
[21] Roger and Garnier: Revue de méd., août, 1906; décembre, 1906; avril, 1910. Soc. méd. des Hôp., 20 juillet, 1906. Presse méd., 23 mai, 1906. Soc. de Biologie, 7 avril, 1906; 7 juillet, 1906.
[22] Whipple, G. H., and Van Slyke, D.: Jour. Exper. Med., Aug. 1, 1918, Vol. xxviii, No. 2, pp. 213–221.
[23] Cooke, J. V., and Whipple, G. H.: Jour. Exper. Med., Aug. 1, 1918, Vol. xxviii, No. 2, pp. 223–241, 243–252.
[24] Hartwell, J. A., and Hoguet, J. P.: Jour. A. M. A., 1912, lix, p. 82.

A FUNDAMENTALLY NEW TECHNIC FOR INGUINAL HERNIOTOMY.*

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This addition to the stream of discussion of inguinal herniotomy technics shows that I agree with those who feel that our statistics in this operation are materially better than our results. Further, that through a thorough study of the underlying anatomy, physiology and pathology, I am hopeful of having been able to grasp some hitherto not properly evaluated principles. My previous reports were on " The Cause and Prevention of Hernia "[1] and " A Suggested Step in Technic "[2] really a preliminary report of this completer discussion.

Beyond reasonable doubt Bassini's operation[3] marks a turning point in the history of inguinal herniotomy, for it is only after his report that we are justified in speaking of radical cures. His essential contribution is, in my judgment, the resection of the inguinal canal portion of the hernial sac, which he accomplished both theoretically and practically. Before his report, surgeons did not completely resect the sac, while since that time resection or at least destruction of the sac is the *only* universal feature in all technics. This procedure alone will probably cure at least three out of every four small or even medium sized hernias. The fact is, the Kocher technic,[4] which is concededly nothing more than a decidedly complicated method for high ligation of the sac, gave rise to the reports ranging from 92 to 97½ per cent. permanent cures—fully equal to the Bassini reports of the time. While the Kocher method has justly gone out of fashion on account of its contra-indications and dangers, it remains for the student one of the most interesting and instructive phases in the history of inguinal herniotomy. While the original Bassini technic and the Bassini modified to bring the internal oblique and transversus muscles in front of the cord still have many adherents, the strong tendency throughout the world during later years has been to reinforce these muscles by flaps from the external oblique aponeurosis. This newer principle, generally known in this country as the Andrews imbrication method,[5] in Europe as the Girard procedure,[6] has a large and apparently unending list of minor modifications.

Inasmuch as anatomy forms the foundation on which every herniotomy must depend, and a large gap exists between the anatomist's and surgeon's description of the inguinal canal, let me here review the essential facts and add what I consider salient, though from surgical papers generally omitted points. The belly wall from without inwardly is made

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up of skin (cutis), subcutaneous fatter layer (panniculus adiposus), deep fascia—the muscles with their aponeuroses—deep fascia, an extraperitoneal fatty layer and finally internally the peritoneum. The spread-out tendon of a muscle, called an aponeurosis, is made up of paralleling strands of white fibrous connective tissue. The term fascia means wrapper, which in this region as per routine encases the muscles and aponeurosis on both surfaces. As both aponeuroses and fascias are made up exclusively of white fibrous connective tissue, they are indistinguishable either grossly or microscopically; in other words the distinction between these terms rests solely on their function. The part of this layer of deep fascia against the transversus muscle and continuing down to the inguinal ligament of Poupart receives the special name of transversus fascia.

With this explanation every surgeon should be able to understand the accompanying diagram of inguinal hernia, which strikes me as the simplest possible (see Fig. 1). The self-explanatory terms abdominal and subcutaneous rings (annulus inguinalis abdominalis et subcutaneus) are used in the Basle Nomina Anatomica revision of anatomical nomenclature (B.N.A.) instead of the old terminology (O.T.), internal and external rings, respectively. Further, the transversalis muscle has been changed to transversus. As the terms external and internal have been widely used both in relationship to the midline of the body and to the depth from the surface, all modern anatomists have discarded the terms external and internal in relation to the midline of the body, and in their place substitute lateral and medial. This is a typical example of the possibility of confusion in the old terminology, for the external, that is superficial, ring is internal as related to the midline of the body. The subcutaneous ring and the anterior wall of the inguinal canal are correctly described and understood in most anatomic tests, but the abdominal ring and more particularly the posterior wall seem to have been universally overlooked or misunderstood by surgeons. To describe the posterior wall, from inside the abdomen outwards are the peritoneum, a variable layer of extraperitoneal fatty tissue and the transversus fascia; this transversus fascia is reinforced across its anterior surface by the falx aponeurotica inguinalis and the ligamentum interfoveolare of Heesselbach, as shown in Fig. 2. The falx aponeurotica inguinalis (falx-sickle) is that part of the insertion of the combined internal oblique and transversus aponeurosis, which attaches to the inguinal ligament and also along the pectineal line of the ramus of the pubis for a variable distance laterally, averaging perhaps about an inch and a half. Its lateral edge thins out and blends with the transversus fascia. The ligamentum interfoveolare (fovea-pit) extends from the inferior margin of the transversus muscle, anterior to the transversus fascia, and blends inferiorly with the inguinal ligament of Poupart. As muscle fibres continuous with the transversus run into this ligament, His[7] in a minority opinion suggested calling this structure the musculus and

aponeurosis interfoveolare. When well developed the edges of the ligamentum interfoveolare and the falx aponeurotica inguinalis blend, so that no medial fovea exists. The fact is Henle,[8] one of the early students of the problem, considered blending of the edges the normal anatomic condition. However the anatomists may finally settle the finer technical points, the essential fact is that the whole area between the inferior margin of the transversus muscle and the inguinal ligament of Poupart is protected by the transversus fascia, reinforced throughout most of its extent by broad sheets of aponeurosis. The only anatomic opening is where the cord (funiculus spermaticus) pierces the transversus fascia and this is reinforced at its danger point, inferiomedially, by the inferior portion of the ligamentum interfoveolare.

All anatomies, so far as noted, stressed the importance and strength of this transversus fascia and the overlying aponeurosis layers. Most of the surgical discussions on the other hand simply mention this fused layer mechanically, without laying one particle of stress on it, or even go to the extreme with Pólya,[9] who after a very complicated description states its strength is not worth considering. Which brings us to the question of which group are correct and how this difference of opinion came about? I believe the anatomists are correct in their description of what they are much more familiar with, *i.e.*, the normal status, while those surgeons who do not admit it has any particular strength are describing the abnormal, *i.e.*, when the layer has become atrophied under continued pressure of a very large hernia, or more particularly when it has been damaged by a previous operation. I agree emphatically with the anatomists that this fused aponeurosis fascia layer is functionally the essential factor in keeping intestines from entering the inguinal canal. The fact is, this layer is sufficiently strong in practically all individuals to prevent hernias from really entering the inguinal canal, except at its point of least resistance along the spermatic cord. In my dissecting room tests of the six bellies opened this year, I could not push my gloved finger through the transversus fascia aponeurosis at any point, except directly against the spermatic cord. Genuine direct hernias are simply a relaxation and bulging outward of this layer, and practically never form a true sac or enter the scrotum. (See Moschowitz's discussion, [10] page 42.) This is popularly very much understood because many surgeons diagnose every large-necked hernia, which from its nature extends down close to the lateral margin of the rectus muscle as direct. On the other hand, fully half of the hernia recurrences are direct, but this only shows that after our usual herniotomy technics this layer is no longer strong and resistant—a proposition I will discuss in more detail later. For those surgeons still skeptical about the normal strength of this fascia aponeurosis sheet, a simple test in their next small or medium-sized herniotomy would be to put their index finger through the neck of the hernial sac into the belly cavity and then press forward against the layer. On their conclusion

from this test I am willing to rest this anatomic discussion of the posterior wall of the inguinal canal.

With these preliminaries out of the way I am ready to give the theory on which I developed the operation now to be described. As a matter of fact I worked out my own theory, but as Bassini went at the position on absolutely the same basis, I will quote him. Let me translate those characteristic statements as literally as possible (Arch. f. klin. Chir. vol. xl, p. 435). " I thought to myself that this could be worked out by means of the rebuilding of the hernial canal, as this exists under physiologic conditions, that is, a canal with two openings, an abdominal and a subcutaneous, further with two walls, a front and a back through the middle of which the spermatic cord would run obliquely." Later on page 441 he rediscusses the physiologic anatomy of the canal and then states, " In order to make possible the radical cure of inguinal hernia, it is, according to my contentions, indispensable that the original psychologic (valve) type of the inguinal canal be reproduced."

In my judgment, his theory grasped the essence of the problem, and even after the lapse of a generation I would not have the slightest desire to modify his statements one iota. But from the various operations advocated and used, it is self-evident that the surgical world has gotten further and further from his conception—in a word, has passed on and forgotten. But when Bassini came to applying his theory to practice, I personally feel that he made a grievous mistake, which chanced to swing the tide of all effort in the wrong direction. And so far as I could find out not a single protest has ever appeared in this literature until my preliminary report. It seems impossible that others have not hit on the same conception I have advocated, but at any rate they have never been able to influence the tide or even really make their protest heard. Bassini split the aponeurosis of the external oblique, separated out the hernial sac and then tied off the neck of the sac. Everybody followed suit. In justice to Bassini, let me call attention to the fact that on account of the danger of peritonitis during that stage of surgery, most operators refused even to open the hernial sac, using various torsion methods instead. His opening of the sac was a progressive step forward, and he was probably, subconsciously at least, influenced by his anxiety to close off the peritoneal cavity at the earliest possible moment. Bassini then resected the inguinal canal portion of the sac and proceeded to attempt to repair the abdominal ring and posterior wall of the inguinal canal. He aimed to sew the musculus obliquus internus, the musculus transversus and the fascia verticalis Cooperi (old name for transversus fascia and aponeurosis) down to the inguinal ligament of Poupart. But let me quote verbatim, page 437: " For the just discussed suture it is advisable to use silk and interrupted sutures, and to take hold of the three-ply musculo-aponeurotic layer at 2 to 3 cm. from its (lower) edge. The lower two stitches—into lateral margin of rectus."

By what anatomic authority sew the internal oblique and transversus muscles down to the ligament of Poupart? As Bassini quotes none and it is not even mentioned among the occasional anatomic variations in reference volumes, I feel confident that he fell short of his own theory. That is why I feel he made a mistake, which has been universally followed. All of which refers purely to the physiologic anatomy of the canal, and is entirely aside from the question as to whether sewing these muscles down to the inguinal ligament of Poupart will yield a larger percentage of permanent cures. In my judgment, Bassini was right in maintaining he did not transplant the cord but he did transplant the muscles, at least temporarily. These statements apply, in my judgment, with equal force to the so-called anatomic modification, which consists in sewing the internal oblique and transversus muscles down to the inguinal ligament superficial to the cord (Wolfler,[11] Ferguson,[12] Girard,[6] etc.). Bassini unquestionably aimed and thought that he had also sewn the transversus fascia and aponeurosis down to the inguinal ligament, but it is doubtful whether he ever really accomplished that object in even a small minority of his cases. With no protection for the intestines and with the peritoneal cavity closed, only a foolhardy surgeon would ever really catch the transversus fascia in even a single stitch. The fact is, most modern authors concede that they catch only the internal oblique and transversus muscles in their stitches. From the physiologic anatomy basis Bassini was therefore doubly wrong, as he caught the layer he had no warrant for catching and missed the layer he should have caught. No—the only practical way to catch the transversus fascia and aponeurosis is before the peritoneal cavity has been closed; in this operation before the hernial sac has been resected. Which is the practical kernel of my whole discussion.

As to the very important question as to whether, in a satisfactorily healed hernia, the internal oblique and transversus muscles usually remain strongly united to the inguinal ligament and functionably capable, I failed to find a single reference in a right intensive search. A recent German article by Drüner[13] refers to the conception that the internal oblique and transversus remain attached and functionally capable as an assumption which is no longer generally believed, but he does not give any special reference. Lameris[14] evidently had some well merited curiosity on this point, as he tested the Bassini operation with the usual stitching of the internal oblique plus transversus to the inguinal ligament, as contrasted with absolutely the same technic except for omission of these stitches. His results on indirect hernias exclusively, checked at 1 to 1½ years postoperative are given in table 1. In 1918 he reported a second series, without stitch, which was done to verify his original results. The details of this second series, included in the same table, can be located through reference.[15] As this .4 per cent. difference between the two groups is well within the normal variation of figures, his evidence would tend to show that the attempt to sew those

muscles to the inguinal ligament of Poupart is an unessential and at any rate minor factor in the result.

In recurrent cases Pólya[9] and in this country Moschowitz[10] report observations on these muscles being separated either in part or throughout, or becoming as thin as sheets of paper. But they both consider this separation the cause of the recurrence and therefore argued for non-absorbable sutures. Moschowitz, however, seems to glimpse possibilities beyond his conclusion when he states, " The transplanted muscles always tend to pull away from Poupart's ligament; at best there is little tendency for firm union between muscle fibers and ligamentous tissue." In recurrences I have always observed separation of internal oblique and transversus muscle from inguinal ligament, but to date have not had opportunity to examine non-recurrent cases after a lapse of years.

TABLE I.—Statistics of Lameris of Utrecht University.

Indirect hernia only	Number of cases	Recurrences	Percentage
With stitch (internal oblique to inguinal lig. of Poupart.)	511	20	3.9%
Without stitch (internal oblique to inguinal lig. of Poupart.)	443	21	4.7%
Without stitch (internal oblique to inguinal lig. of Poupart.)	177	6	3.4%
Total without stitch.....................	620	27	4.3%

Which brings us to the much mooted question as to whether it is weakness in the muscles, or aponeuroses and fascia, as cause of hernias. And the answer strikes me as very obviously both; for if the muscles are paralyzed the resultant relaxation of the aponeuroses and fascias allows a hernia to gradually force its way out; while on the other hand, anatomically, both walls, the subcutaneous ring and even the greater part of the abdominal ring are formed exclusively by aponeuroses and fascias. Further, not only do I believe that sewing the internal oblique and transversus muscles down to the inguinal ligament will not accomplish any good; but, let me add, the more conscientiously an operator attempts it, the worse will be his results. For if he just picks up a few muscle strands in his stitches, little damage will have been done when his stitches cut through; whereas when he gets a good grip on both muscles and inguinal ligament and attempts to really pull these layers together—well, the most fortunate outcome possible, in my judgment, would be to have his knots untie. The universal directions are to pull these layers together without undue tension, to which I now answer that even in average cases it cannot be done. I believe these stitches cause pressure necrosis and in a short time cut through the muscles or inguinal ligament to the point at which excessive tension is relieved. Which means the destruction of a certain amount of muscle tissue, but what is practically of even much greater importance, the loss of motor nerve supply to the muscle, medial to the injury.

This to my mind accounts for the great percentage of recurrences medial to the inferior (deep) epigastric artery, whereas without preceding operative intervention true hernias scarcely ever form in this region, *i.e.*, the medial focea.

After all these complicated facts and theories, the steps in my technic are simplicity itself. Using the routine skin incision, I go down into the aponeurosis of the external oblique opposite the abdominal ring, even in primary operative cases, and then work somewhat more cautiously as I approach the cord exit at the subcutaneous ring. Inserting a blunt-pointed forceps through the subcutaneous ring just under the external oblique aponeurosis, I split this aponeurosis, being careful to remain in the direction of its paralleling strands (see Fig. 3). Then lift up the spermatic cord and hernial sac en masse and dissect out the inguinal portion of the sac (see Fig. 4). Then open the sac and insert my right finger through the abdominal ring, examining its boundaries, locating the deep epigastric artery, and finally testing the whole of the posterior surface of the transversus aponeurosis-fascia down to the lateral border of the rectus muscle. The question of intestinal adhesions, sliding hernias and bladder proximity should also be watched for, because, if present, they obviously call for special watchfulness in subsequent steps. In recent cases the tissues around the abdominal ring ordinarily do not feel especially strong, but in cases of longer standing these tissues tend to become thickened and even contracted down, which I interpret as Nature's attempt at cure. The fact is, this scar tissue and tendency towards contraction was so marked in the majority of long-standing small and medium sized hernias as to make me feel that Nature was generally ready to help out the surgeon who failed to close the abdominal ring effectively. As regards the transversus fascia and its overlying aponeurosis, I have been throughout impressed by its strength, even in certain cases in which relaxation could be noted by external examination. For example, I have never chanced to find any localized weak point, which tempted me to reinforce by overlapping or stitching, although I have been on the lookout for it—except of course in recurrent cases.

To close the abdominal ring I cut off the hernial sac to within about one-quarter inch of the ring (see Fig. 5); then by means of three or four forceps around the circumference I hold the ring well open and insert my suture as shown in Fig. 6. Full curved, medium sized needle, round point, No. 2 tanned catgut, using mattress principle; in children or weaklings No. 1 tanned fulfills all requirements. A simple running stitch is not at all equivalent to these mattress stitches either theoretically or practically. The first suture through the transversus fascia and aponeurosis about one-quarter inch beyond the ring margin as determined by palpation, then out through sac; and then a good grip on the inguinal ligament of Poupart, that is between one-eighth and one-quarter inch from edge, which means that it really catches the fascia lata of the thigh and the aponeurosis of the external oblique as well; then into the neck of
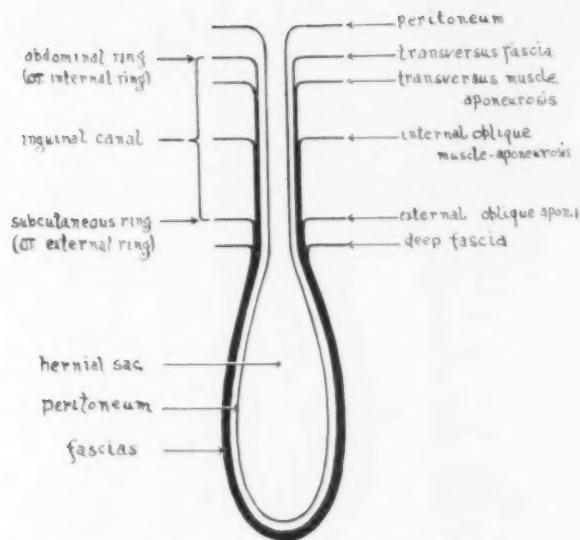
FIG. 1.—Diagram of Inguinal Hernia (From the authors Fundamentals of Human Anatomy— C. G. Mosby Co.—1920).
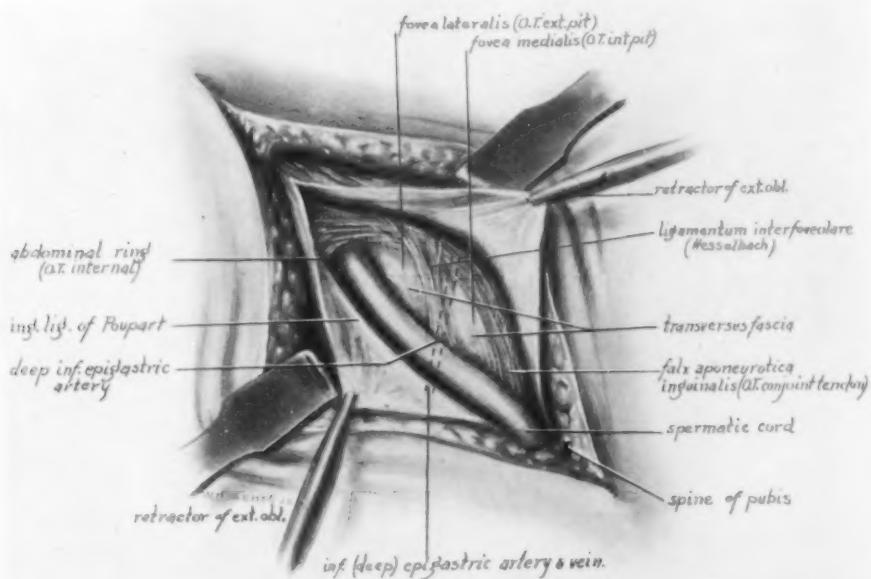

FIG. 2.—Anatomy of Inguinal Region (Extra-fascial fat removed).
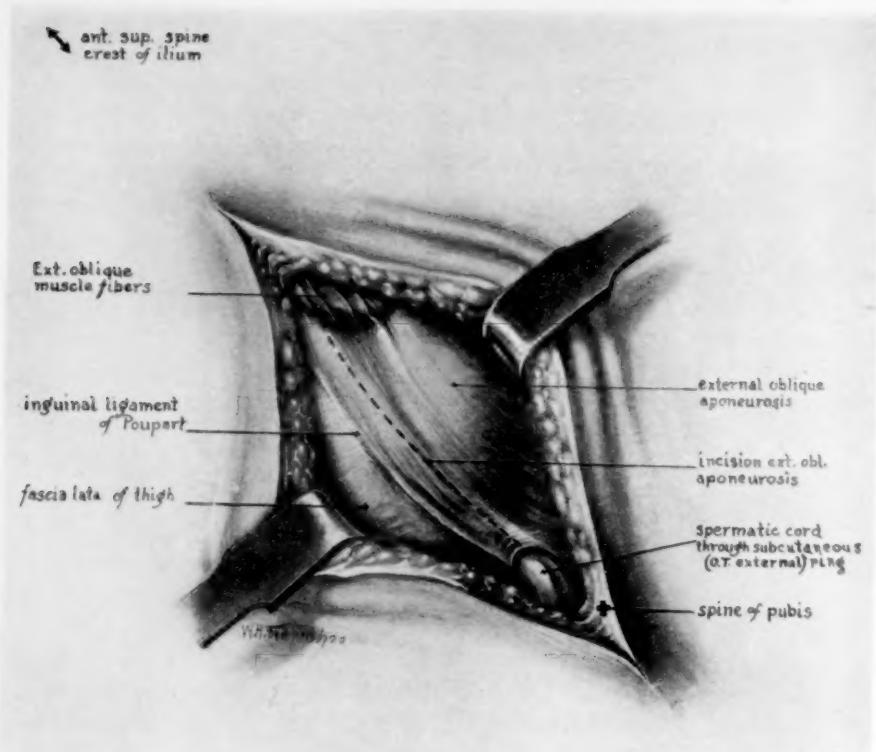
FIG. 3.—Exposure of operative field.
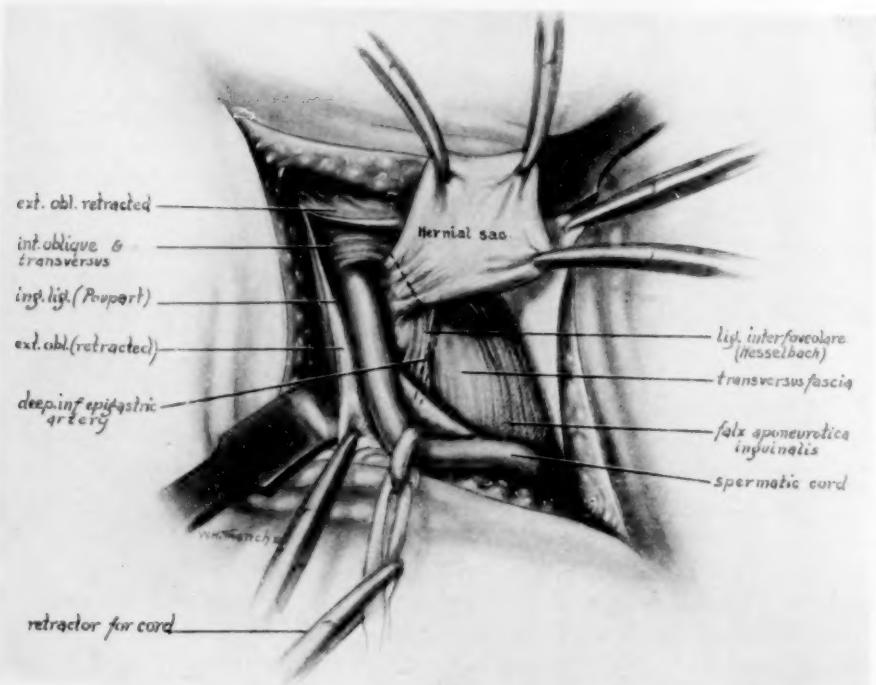
FIG. 4.—Separation of hernial sac.

opening into
peritoneal cavity

deep
epigastric artery

ext. obl. aponeurosis

ext. obl. aponeurosis

resection line
neck of sac

lig. interfoveolare

transversus fascia a
medial fovea

Falx aponeurotica
inguinalis
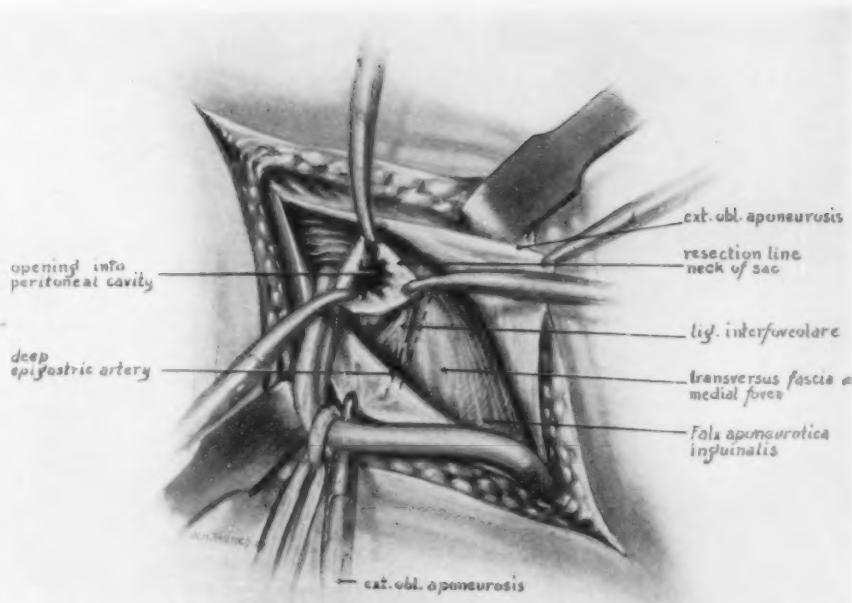
Fig. 5.—Resection of hernial sac.

suture   1

suture 2

ext. oblique
retracted

int. obl. + transversus M.
aponeuroses + fascias

neck of hernial sac

epigastric artery
& vein

ing. lig. of Poupart

retractor for Cord
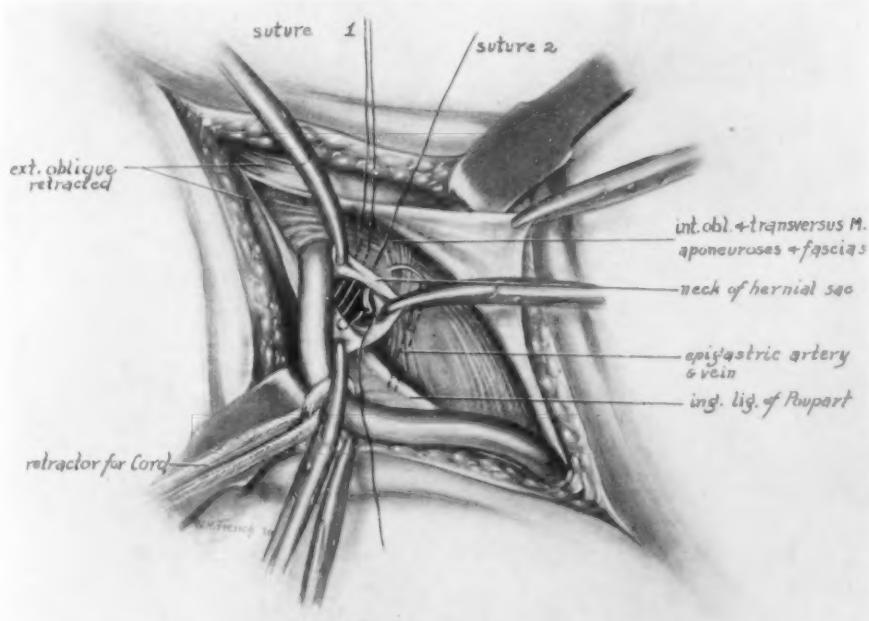
Fig. 6.—Insertion of interrupted sutures.
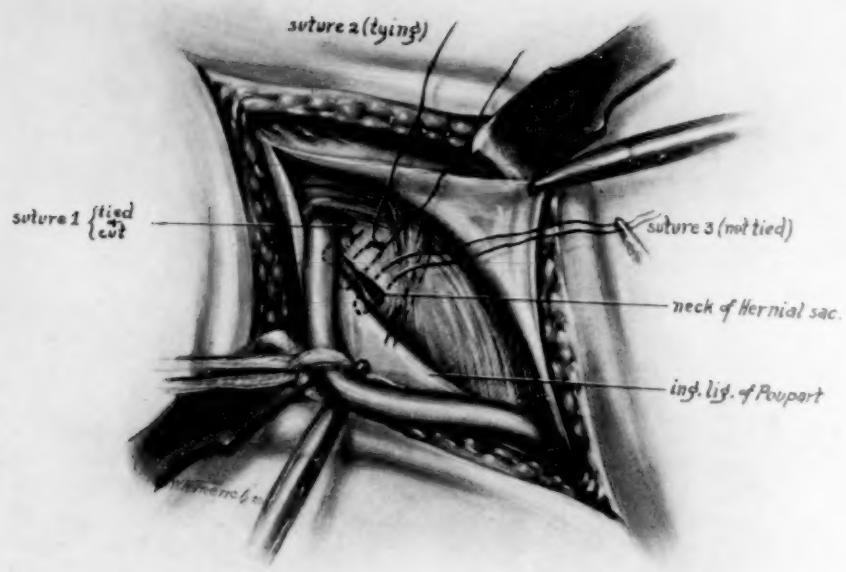
FIG. 7.—Tying of sutures.
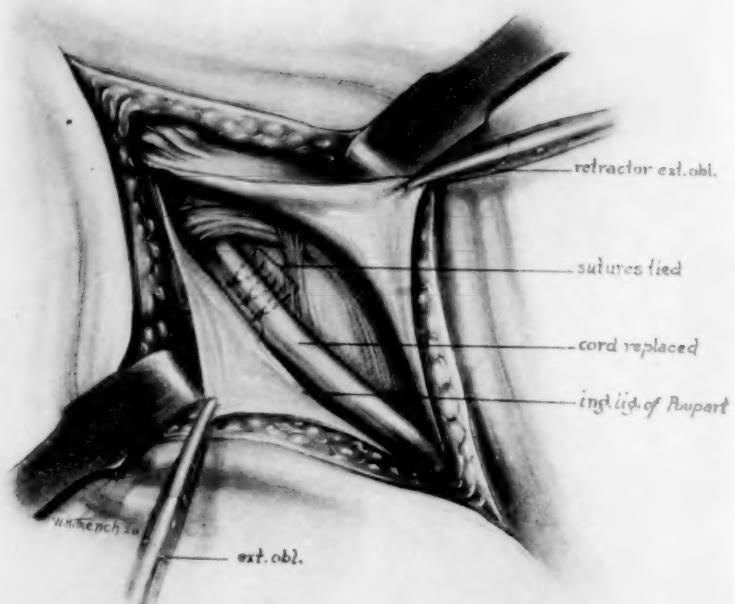
FIG. 8.—Replacement of cord.
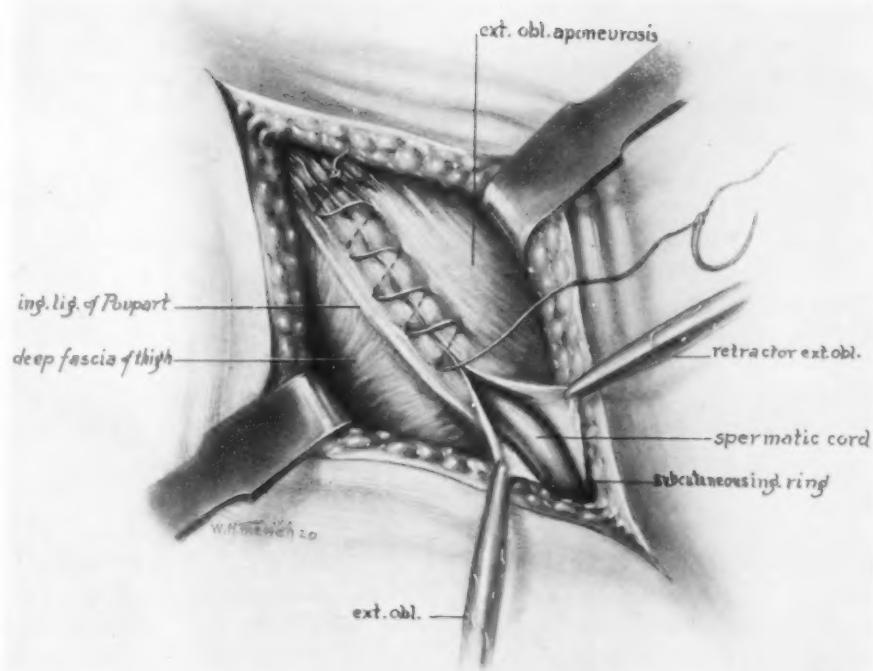
FIG. 9.—Suture of ext. oblique aponeurosis.
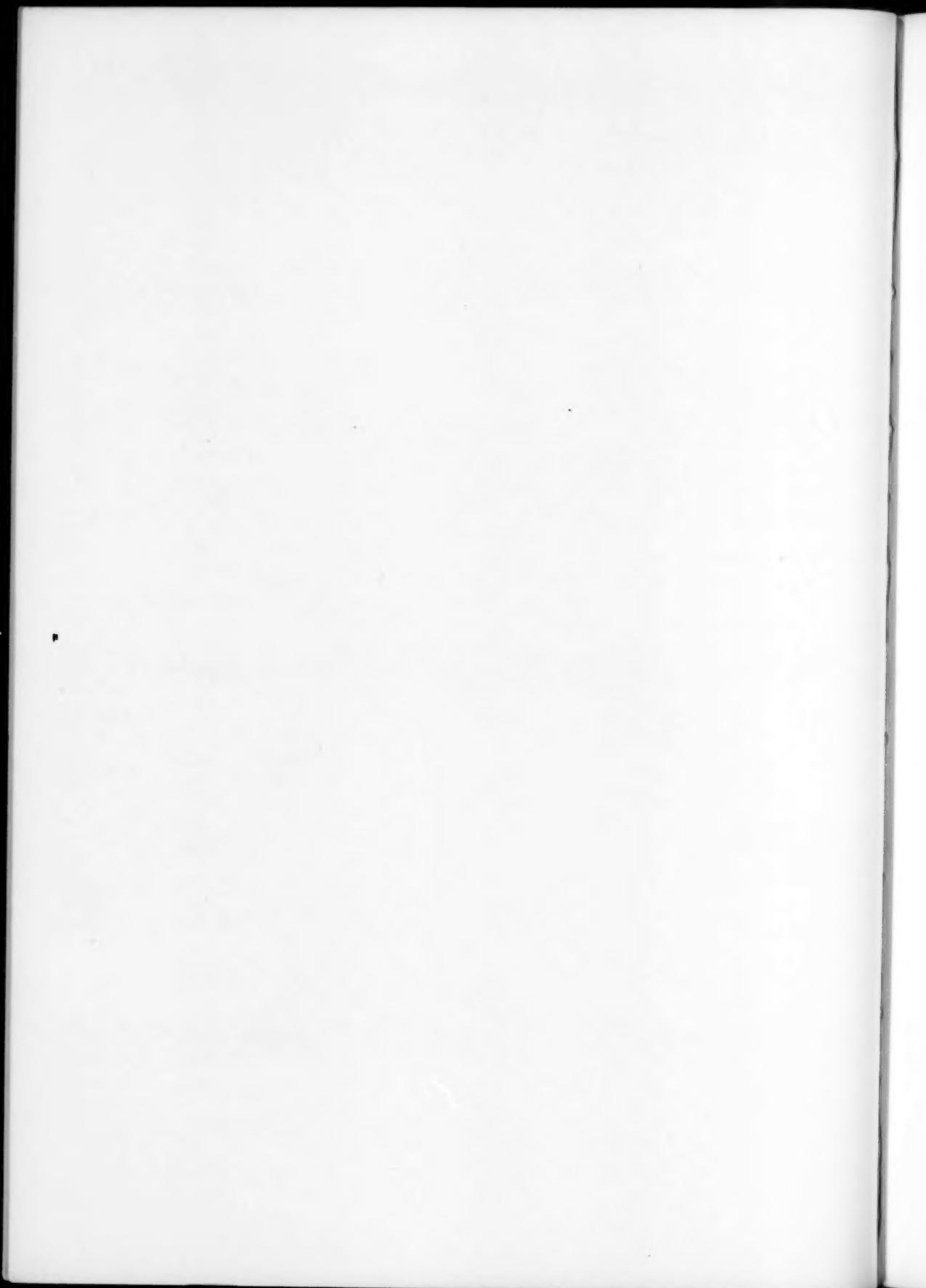
the sac and through the transversus fascia-aponeurosis from within out-
wardly at somewhat over one-eighth inch from start of this mattress
suture. Absolutely reversing the usual procedure, I avoid the internal
oblique muscles as much as practical in inserting these sutures, in fact use
a retractor to get these muscle fibres out of the way whenever they
overlap the opening in the transversus fascia-aponeurosis. Of course the
inguinal ligament should be absolutely cleared and also lifted up to avoid
the possibility of injuring the femoral vein. The first suture should be
placed sufficiently high so as to just leave room for the cord when the cat-
gut is drawn down tight. Remaining sutures spaced about one-fourth
inch apart on absolutely the same principle; which means a total of two,
three, four and even five or more, as the individual case may call for.

The accompaning plates picture the repair of an average hernia, but
let me emphasize here that the same principles in my judgment underly
the repair of all inguinal hernias. In many cases one suture reduces the
opening in the transversus fascia-aponeurosis to its normal size, while
when the split in this layer has extended down to the lateral margin of
the rectus muscle, obviously about a half dozen sutures are required.
As any established technic will cure the overwhelming majority of small-
necked hernias, my interest centres in the use of this technic in the
medium, large and largest-necked hernias. Whether these very large-
necked hernias are primarily direct, or, as I agree with Moschowitz and
others, indirect, is a point of only academic interest as far as this opera-
tive procedure is concerned. For whether or no, the underlying prin-
ciple of this technic is to restore valve action by the effective repair of
the posterior wall and the abdominal (O. T. internal) ring.

After all the required sutures are inserted they are snugly tied from
above downwards, three knots and over ⅛-inch cut, as otherwise catgut
is very liable to untie and my theory is to have these layers hold together
for at least ten days (see Fig. 7). These stitches, I claim, can be tied
without undue tension in most all cases. In regard to the very slight
amount of tension necessary to hold the opposing layers together, catgut,
being materially larger than silk or any other non-absorbable suture now
used, has decidedly less tendency to cut through the tissues. If in any
individual case coaptation without undue tension could not be acomplished,
I would certainly feel that this indication called for the insertion of a free
aponeurosis-fascia transplant, which I would borrow from the thigh. (See
Kirschner's [16] experimental work. In my judgment the adantage of
a neighboring flap, with its temporarily better lymphatic circulation, is
much more than counterbalanced by its injury to the strength of the abdom-
inal wall, which is—lest we forget—what we are out to repair. But if you
just must have a pedicled flap, my suggestion would be to borrow it from
the front of the thigh.

The cord is then placed in its normal position and the aponeurosis
of the external oblique sewed over it (see Figs. 8 and 9). Whenever
a large hernia has caused a stretching of this aponeurosis I take out the

slack by overlapping the edges. At the subcutaneous ring the normal triangular slit, just large enough for the cord, should be reproduced as nearly as possible. To prevent a dead space I sew the subcutaneous fatty layer with a running stitch, and then close the skin, also with catgut. To clear the tissues rapidly and well, I make use of the well known gauze dissection, tie only the larger vessels in closing up, and depend to a great extent on a firm spica-dressing to minimize the early post-operative hemorrhage incidence. In inserting the deeper sutures I am always on guard to avoid the deep inferior epigastric artery, even though I rather feel it would ordinarily get out of the way of a round pointed needle. The accompanying vein is both theoretically and practically more readily caught by suture, but on tying this hemorrhage usually ceases. At times, however, I imagine persistent bleeding might call for special ligation. As regards the theoretical risk of having stitches go through into the peritoneal cavity, my contention is that they sink into the delicate endothelial layer and are covered over within a few hours.

This concludes my paper, as I am not going to attempt statistics of a recent limited series, more particularly as I feel that the value, or lack of value, of any proposed particular technic can only be determined by the results of other than the originator. As this technic has as its maximum aim the restoration of the dilated inguinal canal to its normal strength, naturally there will be recurrences, if the individual repeats the error which developed the hernia originally. The acme of technical possibility strikes me as being that our patients should be able to do what a corresponding normal group of individuals can do, with no greater liability for the development of hernia—nothing more and nothing less! Personally I have developed such a profound respect for anatomy as related to function that, if any non-anatomic technic lasts, I will always feel that somehow nature rebuilds and so compensates for the surgeon's error. As a final word let me simply add my firm conviction that if the theory of this operation is better ipso facto the practical results will be better.

SUMMARY

1. Size and endlessness of the stream of inguinal herniotomy technics raises the strong suspicion that something is fundamentally wrong.

2. The essentials of the original Bassini, the Kocher, and the more recent imbrication technics, Girard-Andrews.

3. The anatomy of the inguinal canal, with special stress on the posterior wall and abdominal ring—including a detailed discussion of the transversus fascia, the falx aponeurotica inguinalis and the ligamentum interfoveolare.

4. Differences between the anatomist's and the surgeon's description and conception of the inguinal canal.

5. Bassini's original theory of the operation, which, verbatim, fulfils my conceptions completely.

6. The basis for my conception that Bassini failed to apply his theory correctly to practice.

7. In order to catch the transversus fascia and overlying aponeurosis in the stitches, it is in my judgment absolutely necessary to insert the stitches before the hernial sac has been closed.

8. Questions as to whether the internal oblique and transversus muscles remain functionally attached to the inguinal ligament of Poupart in even non-recurrent cases.

9. The evidence that both normal muscles, and normal aponeurosis and fascias, are essential to prevent and cure hernias.

10. Technic of my operation, the essential step being to sew the transversus fascia and aponeurosis—and only these layers—down to the inguinal ligament of Poupart before the peritoneal cavity has been closed.

11. The reasons why I feel that this technic is universally applicable to all inguinal hernias, small or large, direct or indirect, primary or recurrent; especially advocated for medium and large-necked hernias.

12. The aim of this technic is simply to minimize recurrences, including why, as a practical proposition, some recurrences will always occur.

CONCLUSIONS

The underlying principle of this operation for the repair of all types of inguinal hernia is the reproduction of physiologic valve reaction by (a) resection of the hernial sac, (b) actual effective repair of the enlarged opening in the transversus (transversalis) fascia (c) avoidance of injury to the internal oblique and transversus muscles.

REFERENCES

[1] Pitzman: Cause and Prevention of Hernia. Jour. Amer. Med. Assn., 1917, vol. lxix, pp. 776–777.

[2] Pitzman: Suggested Step in the Technic of Inguinal Herniotomy. Surg., Gyn. and Obs., 1919. vol, 28, pp. 329–331.

[3] Bassini, E.: Arch. f. klin. Chirurgie, 1890, vol. xl, pp. 429–476.

[4] Kocher, Th.: Chirurgische Operationslehre, 5th edition, Jena, 1907, p. 760; also in English translation by Stiles and Paul. London, 1911, p. 518.

[5] Andrews, E. W.: Surg., Gyn. and Obs., 1906, vol. ii, pp. 89–94.

[6] Girard, Ch.: Correspondenzblatt f. Schweitezr, Aertze, 1894, vol. xxiv, pp. 186–189; also 13th Congress International, Paris, 1900, Surgial translations, vol. x, p. 431.

[7] His, W.: Arch f. Anatomie und Entwicklungs Geschichte, Supplemental Band, 1895. "Die Anatomische Nomenclature." pp. 121–124.

[8] Henle: Myology, 1st Edition, p. 71.

[9] Pólya, E.: Arch f. klin. Chir., 1912, vol. cix, pp. 816–877.

[10] Moschowitz, A. V.: In Johnson's Operative Therapeusis, Appleton, 1915, vol. iv, pp. 1–134.

[11] Wolfler, A.: Beitrage zur Chirurgie, Festschrift Theodor Billroth, Stuttgart, 1892, pp. 552.

[12] Ferguson, A. H.: Jour. Amer. Med. Assn., 1899, vol. xxxiii, pp. 6–14.

[13] Drüner: Deutsche Ztschr. f. Chir., 1919, vol. cl, pp. 7–50.

[14] Lameris, H. J.: Deutsche Ztschr. f. Chir., 1912, vol. cxix, pp. 569–580.

[15] Lameris, H. J.: Zentralblatt f. Chir., 1918, vol. lxv, pp. 764, 765.

[16] Kirschner, M.: Beitr. zur klin. Chir., 1909, vol. lxv, pp. 472–504.

INCOMPLETE RUPTURE OF THE AXILLARY ARTERY

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While complete and open ruptures of the big vessels have been well described by the military surgeons of the last century, incomplete ruptures of the arteries did not attract so much attention at that time. However, this condition had been known for many years in civil practice and it has been the subject of several important observations during the World War.

The management of these cases is still far from satisfactory; no definite method of treatment has been evolved so far; and for this reason these injuries should be more frequently reported in order to stimulate surgical thought and reflexion that will eventually lead to a more active and effective therapy. Here is a short account of the two cases we have observed:

Case No. I. *J. W.*, fifty-five years old, farmer, was thrown from an automobile on August 27, 1918, injuring his left shoulder. He came to San Francisco on August 30, 1918, with the diagnosis of fracture of the surgical neck of the left humerus, attended by great displacement of the lower fragment (shaft) into the axilla. From the day of his admission no pulse could be felt in the radial, ulnar or brachial arteries at any time. The fifth finger was white and swollen, but the patient could still move all his fingers. On September 8th, a patch of ischæmic necrosis appeared on the ulnar side of the forearm near the wrist.

After two unsuccessful attempts at reduction had been made, we performed, on September 9th, an operation consisting in the excision of the humeral head and reduction of the shaft into the glenoid cavity. But the ischæmic gangrene kept increasing slowly until the patient finally lost four fingers with part of the metatarsals, the forearm remaining in a typical state of Volkmann's ischæmic paralysis.

Injuries of this kind are well known in the surgical literature; the only point of interest lies in the fact that in this case we could inspect and feel the thrombosed axillary artery exposed during the operation, it was spindle shaped, hard and pulseless; the adventitia was still intact, so that a diagnosis of rupture of the tunica intima and media was made. The thrombus appeared to be from two to two and one-half inches in length and its removal, followed by double ligation of the axillary artery, would have been quite feasible, but we were not sufficiently familiar with the condition and with the more recent publications thereon to dare to take such a risk at that time.

Case No. II. *A. M.*, twenty-nine years old, railroad conductor. On December 5, 1920, while engaged at coupling two railroad cars, he was caught between one car at his back and a heavy piece of timber projecting from the car in front and pressing against his sternum; he esti-

mates that he stayed in that position for thirty-five seconds, and while his thorax was held tight between the two cars he tried to signal to the engineer of the train by waving his left hand. He says that he extended his left arm three or four times and then dropped it towards the ground. In the local hospital soon after the accident it was found that the second and third costal cartilages on the right side were broken, near the sternum. His left arm was numb and heavy, but he had no pain in it. The third, fourth and fifth fingers were ice cold. The radial pulse was absent.

On December 7, 1920, we examined the patient in San Francisco. His general condition of health was excellent. As to the left arm there was no pulse in the radial, brachial or axillary arteries. The arm was cold and anæmic, but a faint pink color could always be detected near the lunula of the nails. The fingers felt numb and heavy, but he could move them. The skin and muscles were perfectly soft; we watched the patient every day for the appearance of any ischæmic patches, but none came. He was treated with constant warm applications to the whole arm and rest in bed for several weeks, on account of the danger of embolism. There was no swelling or sign of extravasation about the neck or the axilla.

On January 2, 1921, the pulse was still absent, but the influx of blood was apparently sufficient as the arm was warm and the skin veins were beginning to show very well; it was also noted that the man had a much better grip.

On January 13, 1921, thirty-nine days after the accident, a faint pulsation could be felt in the radial artery; then it disappeared.

On January 18, 1921, forty-four days after the injury, the pulse could be felt again; it was soft but quite distinct.

On February 12, 1921, ten weeks after the injury, the pulse was excellent, the muscles were soft and strong. There was no pain and no swelling of any kind about the axilla.

So it took ten weeks for the collateral circulation to be firmly established in this case.

Remarks: *Etiology and Mechanism.*—(a) Rupture of the inner coats of the arteries may be caused by direct violence applied to the vessel, for instance, in the case of a wagon wheel going over a limb (Lejars), or in hanging and strangling (Herzog); or if a bullet or a piece of shell strikes an artery directly but weakly and tangentially (Sencert, Anderson, etc.).

(b) The rupture may be due to indirect shock or contusions, as in fractures and dislocations, or when the bursting of a muscle is caused by bullet or a shell (Hydraulic pressure of Gregoire). Sencert, Dobson, Higgins and other military observers all confirm the fact that a bullet passing at a distance from an artery (and not through it) may set up such a *vibration* and shaking up of all the parts as to cause a tear in the vessel.

(c) Another mechanism is by elongation or overstretching. The best example of this is the case of Turner (quoted by Lejars) of a patient putting his hand in his hip pocket, after which the artery was found obliterated. Our Case No. II evidently belongs in this category.

All military surgeons (Anderson, Sencert and others) assert that a piece of shell going through a limb can have the same action by putting an artery on the stretch.

All these mechanisms are certain and all have been verified at operation and at post-mortem.

According to the experiments of the French Military School, quoted by Sencert, there are three degrees of injuries to the internal coats of an artery.

1. In the first degree, a few lines (or cracks) are seen in the intima alone.

2. In the second degree, ruptures of the intima and media are found with some curling of the torn edges, but these are limited.

3. In the third degree there is a complete circular rupture of the intima and media.

The consequences of such lesions vary to a great extent (according to Sencert). In mild cases with a very small thrombus, no changes or only a slight narrowing of the vessel may be present; in others, the injured vessel is spindle shaped, owing to the distention of the adventitia. In others, the thrombus may be so long as to fill the first, second or third collateral. Again in other cases the thrombosis may be so extensive as to reach the next big artery (carotid) and this has resulted in embolism and hemiplegia in several instances.

Diagnosis.—Sencert states that in mild cases with a small thrombus the symptoms may be transitory, the pulse being present all the time, but these are surely exceptional.

In the great majority the absence of arterial pulse is the most striking symptom, and if the extremity is pale, cold, insensible, the diagnosis of a ruptured artery is certain.

In severe cases the ischæmia may appear from the beginning, as indicated by pain, cyanosis, edema, impairment of motion and the peculiar hard consistency of the skin and muscles of the affected areas.

The surgeon will do well to look out for any sign of incipient ischæmia before he undertakes any intervention, and to have one or two of his colleagues in consultation, otherwise if the gangrene should become apparent after the operation (such as reduction of fractures or dislocation) the patient will not fail to regard the surgical intervention as the cause of the trouble.

As to the differential diagnosis between complete and incomplete rupture of an artery, we have to bear in mind the fact that, owing to the curling up of the inner coats, a complete rupture of a large artery may take place without hemorrhage or hæmatoma to speak of. This is known to have arrested the bleeding in many cases of injuries of the large vessels.

Makins states that the diagnosis between contusion-thrombosis and complete division of an artery is impossible if there is no systolic bruit or aneurismal swelling.

In our Case No. II, we have admitted an incomplete rupture of the axillary artery, chiefly because of the absence of hæmatoma and aneurism;

this, however, is only a diagnosis of probability and the rupture may have been more complete than we really thought it was.

Prognosis.—Inasmuch as we have no accurate means to estimate the location and the size of the thrombus, our prognosis should be well guarded both as to the future condition of the limb and as to the life of the patient. Experience shows that only a minority of the cases will be completely cured, The majority will result in amputations and a few in death by embolism.

The prolonged absence of pulse does not necessarily entail a bad prognosis, as instanced in the case of Lejars in which the radial pulse made its reappearance four months after the accident.

Treatment.—Up to the present incomplete ruptures of the arteries have received only palliative treatment, as far as we know.

A direct suture of the vessel is not indicated, of course, in lesions of the inner coats alone. As to other procedures, Anderson has tried Tuffier's tubes and some vein grafts too, he says, without result. Free transplantation of a piece of vein to take the place of a resected segment of artery has succeeded in the treatment of aneurisms and tumors, but has little value in traumatic injuries where the collateral circulation has had no time and no chance to develop.

Anderson seems to regard ligature where not done too early (five or six days after the injury) as the most favorable treatment.

Speaking of complete subcutaneous ruptures with hæmatoma, Lejars says that it is recommended to make an incision, clean out the blood clots and ligate the artery, but he adds that nobody has done it very much.

In the future we would follow the advice of Sencert, which is as follows: In mild cases, with absence of pulse but with no other alarming symptoms, watchful waiting is all that is necessary, with absolute rest of the injured limb, of course. In serious cases, with incipient ischæmia, when one or two fingers (or toes) are decolorized and begin to feel "hard," we know what the patient has to expect—the loss of several fingers or of the whole hand with an extremity that will remain shrivelled up and atrophied; and this seems to justify a more aggressive therapy on our part. This should consist, according to Sencert, in a longitudinal arteriotomy, and removal of the thrombus with double ligation of the artery above and below the point of injury, the fundamental idea being to try to relieve and open up the collaterals. He does not say that he has done it and he does not give any result, but this suggestion certainly sounds rational.

Will it ever be possible to add to this operation some other procedure, such as an anastomosis between two secondary arteries, one distal, the other proximal to the injured joint, done directly or by means of a neighboring vein? For instance, in case of a ruptured axillary artery, could an anastomosis be effected between one of the scapular branches and the profunda brachii directly or indirectly (through a vein?). We know that such a junction between vessels of small calibre is particularly liable to thrombosis. The future will answer this question, but the prospect of Volkmann's ischæmia is so

sad that it ought to spur the surgeons to make all efforts possible in order to prevent this most lamentable occurrence, if it can ever be done.

BIBLIOGRAPHY

Anderson, W.: Contusion of the Arteries. Brit. Jour. of Surg., 1919-1920, vii, 95-98.

Dobson, J. F., and Higgins, W. R.: A Case of Contusion of the Axillary Artery. Brit. Jour. of Surg., 1918-1919, vi, No. 21, 15-18.

Grégoire, R.: Ischémie et Nécrobiose des Membres par Thrombose, Artérielle Traumatique. Presse méd., 1915, xxiii, No. 18, 137.

Grégoire, R.: Ouverture tardive des Arterés dans les Plaies par Projectiles de Guerre. Presse méd., 1915, xxiii, No. 45, 372-373.

Herzog, U.: Ueber traumatische Gangran durch Ruptur der inneren Arterienhaute. Beitr. z. klin. Chir., 1899, xxiii, 643-673.

Hofmeister, F. v., und Schreiber, A.: Die Chirurgie der Schulter und des Oberarms. Hand. der prak. Chir., 1914, v, 1. Abschn., 1-126.

Lejars, F.: Des Ruptures sous-cutanées directes des Grosses Artères et des Gangr`nes consécutives. Rev. de Chir., 1898, 540-565.

Makins, G. H.: On the Vascular Lesions produced by Gunshot Injuries and their Results. Brit. Jour. of Surg., 1915-1916, iii, No. 11, 353-421.

Sencert, L.: Blessures des Vaisseaux. Paris. 1917.

ARTERIAL HÆMATOMA FOLLOWING TRAUMATIC RUPTURE OF THE POPLITEAL ARTERY

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SINCE in a strict sense the word aneurism connotes an actual yielding or dilatation of the wall of a blood-vessel, the term arterial hæmatoma is best used to designate solely those arterial ruptures formerly described under the erroneous and misleading caption, false or traumatic aneurism. Yet, the distinction between a true aneurism and an arterial hæmatoma may become, at least from a histologic viewpoint, wholly artificial, because microscopic study shows that endothelium does not enter always into the formation of the lining of an aneurismal sac. Again, a sac itself may not be entirely composed of structures derived primarily from the wall of the artery. Indeed, the wall of a sac may be formed of firmly compressed and agglutinated layers of thrombus. Nevertheless, a distinction is needed because the surgical treatment of aneurism—obliteration or extirpation of the sac or restoration of the vascular continuity—is wholly different from that of arterial rupture.

A striking example of traumatic rupture of the popliteal artery is the following:

M. D., age twelve, entered St. Francis Hospital May 4, 1920, discharged June 7, 1920.

The previous and personal history of the patient is of no moment.

Present illness dates from an injury of the right leg sustained by falling from a boardwalk three months ago. A swelling which appeared immediately following the accident has constantly but slowly increased in size, without any symptoms of sepsis. The swelling is confined to the lower one-half of the right thigh, and is more prominent over the internal aspect. There is neither heat nor tenderness. The swelling is cystic and tense. A röntgenogram taken by A. J. Quimby, M. D., shows no disease of the bone or periosteum. Despite this negative report a tentative diagnosis of periosteal sarcoma was made.

Operation (May 7, 1920).—Ether narcosis. A longitudinal incision was made over the most prominent part of the cystic swelling. Upon deepening the incision through the muscles of the thigh a large cavity was entered, containing a large amount of black and gangrenous blood clots. These clots, compressed into definite laminæ, formed a distinct wall to the cavity. In attempting to remove the organized blood clots, a violent hemorrhage was encountered. The bleeding being clearly of arterial origin, the common femoral artery was immediately compressed in Scarpa's triangle. The incision was then rapidly enlarged. By holding the margins apart with retractors and asking the assistant to release the pressure from the femoral artery an opening was de-

tected on the inner wall of a large blood-vessel which was afterwards identified as the beginning of the popliteal artery. The wall of the artery was gray and somewhat necrotic. Double ligation of the artery with No. 2 chromic catgut sutures, passed with an aneurism needle, effectively controlled the hemorrhage. Following the insertion of two pieces of gauze into the wound, the remainder of the incision was closed with interrupted sutures. During the latter part of the operation the patient passed into profound shock. The use of Trendelenberg's position and active hypodermic stimulation resulted in an immediate recovery.

The post-operative treatment consisted simply in the daily removal of gauze and packing of the wound. The color and warmth of the limb remained unchanged throughout the convalescence. Pulsation of the dorsalis pedis artery never could be obtained. Complete cicatrization of the wound took place leaving a firm linear scar. Patient was discharged cured June 7, 1920.

The incision, which was about five inches in length, terminated about two inches above the internal condyle of the femur. Compression of the common femoral artery and vigorous retraction of the incision afforded a clear and dry field, in which the ruptured artery could be clearly seen. In the center of the artery, as stated above, was a longitudinal tear, through which blood spurted to a considerable height the moment the compressing finger was released. The accompanying vein could not be isolated. Following the occlusion of the ruptured artery with two hæmostats and the removal of the compressing finger over the common femoral artery, the structure could be felt to pulsate forcibly, proving conclusively that the injured vessel was an artery and not a vein. From the gross appearance of the ruptured artery it was evident that the wall had undergone severe contusion and softening.

The hemorrhage was recognized by the wound filling rapidly with blood and by hearing a hissing sound, indicating the escape of blood under great pressure. Ordinarily, the dissection and exposure of the popliteal artery at this site would be exceedingly intricate. The hæmatoma, however, having dissected and displaced the various muscle planes, made the exposure of the artery extremely simple. Indeed, the increasing pressure of the hæmatoma had eroded, to a definite extent, the posterior surface of the lower end of the femur. The portions of organized blood clot removed manually, constituted the postero-internal wall of the sac. They measured, at least, one-half inch in thickness and resembled greatly portions of placental tissue.

Monod and Vanverts have published an elaborate and trustworthy analysis of the problem of arterial hæmatoma. In a series of 205 collected cases, there were eleven primary amputations, three indirect compressions of the affected artery, forty-one ligations and 157 direct incisions of the hæmatoma.[1] A noteworthy fact in this connection is that, in each instance, among these 157 direct incisions, a secondary operation—tamponade, ligation or arteriorrhaphy—became imperative.

It would appear, that the most efficacious treatment consists in the early

incision of the hæmatoma, since the prompt evacuation of the clots favors the immediate restoration of the collateral circulation. Hæmostasis is assured by double ligation of the bleeding vessel which, happily, may be a collateral and not the main trunk.

Arteriorrhaphy, lateral, longitudinal, circular or oblique, is a feasible method of treatment. Fine round needles and thin durable vaseline-soaked silk sutures are required. Above all, the breach in the wall of the artery must be comparatively small and not devitalized or excessively lacerated, for otherwise a secure closure is not possible. Suture of an injured vein is practicable. The advice of von Oppel to ligate always the accompanying vein of a main artery may be justifiably followed, though it is not clear that the operation rests on a sound basis.

Ligation of the principal artery of an extremity should be avoided, save as a last resort, because this operation facilitates the occurrence of gangrene by suppressing many of the branches most needed in the establishment of the collateral circulation. Moreover, ligation of the main trunk—for example, the common femoral—would not prevent reactionary or secondary hemorrhage from the popliteal artery if the sutured ends of this artery were not ligated. When an open wound exists, direct ligation of the ruptured vessel is simplified. In the absence of an open wound, the classical incisions for ligation of an artery in continuity are available.

No matter the method of treatment employed, drainage is absolutely essential, one important indication being the necessity to detect the early onset of reactionary or secondary hemorrhage.

Preliminary to ligation of a main artery one should make an effort to determine the efficiency of the collateral circulation, for it is evident that, if the collateral circulation be not established, ligation of the main trunk should yield, in order to avoid gangrene and consequent amputation, to the operation of arteriorrhaphy or, perhaps, venous transplantation. The latter procedure, used by Renans in reconstructing the popliteal artery following resection of a popliteal aneurism, is, generally, not feasible in this phase of traumatic surgery. This surgeon utilized a segment of the internal saphenous vein to bridge an interval of seventeen cm. between the separated ends of the popliteal artery.

Numerous tests exist to detect the failure of the collateral circulation. When the circulation is well carried out as evidenced by the non-existence of gangrene or necrosis, though the peripheral pulse be absent, it is evident that the collateral circulation is ample and complete. Again, the cessation of pulsation in a distal peripheral artery is not a criterion that the main trunk is affected, because compression of the main trunk may result from a hæmatoma of a secondary artery. Amberger and Delbet in two clinical reports call attention to the immediate restoration of the peripheral circulation following the evacuation of a hæmatoma. When the peripheral pulse is present, however, it becomes difficult to say whether or not the pulse is secondary or collateral in origin. In this connection, it is interesting to learn that Dob-

rovolskaia[2] maintains that he is able by a detailed study of sphygmographic tracings of the distal artery, to determine the origin, secondary or collateral, of the pulsation. But it would appear from the analysis of Dobrovolskaia's reports, that a considerable error underlies this method.

Korothow has devised a test which consists in a determination of the blood pressure of the toes or fingers following previous exsanguination of the limb and compression of the main trunk. Matas[3], in a clinical application of this test, objects, particularly, to the difficulty met in applying the apparatus. In general, it would appear that the well known Moskowicz hyperæmia test is, perhaps, the best for clinical use.

BIBLIOGRAPHY

[1] Monod, Ch., and Vanverts, J., Revue de Chirurgie, vol. 43, pp. 196, 1911.

[2] Dobrovolskaia, N. A., Revue de Chirurgie, vols. ix-x, Sept.–Oct., 1919.

[3] Matas, Rudolph, Annals of Surgery, vol. lxxi, April, 1920.

FRAGILITAS OSSIUM

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THE condition of fragilitas ossium, known by a number of other names, the more common of which are osteogenesis imperfecta and idiopathic psarthyrosis, is characterized by brittleness of the bones and blueness of the sclera. Eddowes noticed the association between the blue sclera and brittle bones in 1900 and he is generally given credit of being the first to describe this condition although Spurway claims that he reported a case of breakable bones in 1896.

With regard to the etiology, thus far, none of the advanced theories have proven tenable. For a long time the disease was thought to be on a syphilitic basis but this has been disproved; also because of its similarity to rachitic disorder it was confused with this condition.

Heredity plays a small but significant part in fragilitas ossium for, in between nine and ten per cent. of the cases, we have been able to definitely trace the condition back to some relative, not necessarily parents or grandparents. However, often those of a family with predisposition for the disease and having blue sclera are affected and also transmit it to offspring; whereas those with white sclera do not. As only this small percentage of cases can be placed on an hereditary basis, we are left with a much larger group of cases about which we can say little concerning the etiology.

Pathologists report that in addition to a subnormal activity on the part of the osteoblasts there is a deficient deposition of calcium salts and other mineral matter in the ossious system of the patient. The ossification of cartilage is delayed or absent and very little dense bone is found. The bones may be characterized as being pipe-like.

The patients having the condition of fragilitas ossium also have blue sclera in every case. By several authors the sclera are described as being china blue. We have, however, cases of blue sclera in which there has never been any suggestion of fragilitas ossium, as in certain blood diseases and occasionally in tuberculosis, but the association in this disease is constant.

The fractures may occur in prenatal life, in which case they are more commonly confined to the bones of the head with occasionally fracture of the long bones. In those cases where fractures come on after birth we rarely, if ever, have fracture of the cranial bones but have the long bones chiefly affected. As most of the cases which suffer from prenatal fractures are still-born or die soon after birth, we are mainly concerned with the post-natal type. Naturally, the earlier the onset of the fractures, the greater the num-

ber of them the patient is liable to have. In some cases, the liability to fracture decreases with age, and, after the patient reaches thirty years of age, he has no more. Then again other patients still are having fractures at forty-six years of age. The long bones are chiefly affected especially the femurs. In addition to fractures, the bones on account of their imperfect osteogenesis, are very liable to bowing and sprain fractures are also very common. Because of the many fractures and the bowing, the majority of these patients are short in stature.

In all the case reports reviewed there was no reference to an abnormal condition of the teeth. Practically all referred to the teeth as negative or in good condition. In the case we are reporting, the child has a very interesting condition of his teeth. They are almost translucent and show every evidence of lack of mineral salts. The mother informed one of us that the first teeth were the same and did not last any time at all but were so fragile that they soon crumbled. The permanent teeth seem much the same as the deciduous set in this regard.

Radiographically we notice the shafts of the long bones are very thin in comparison to the size of the epiphyses of the same bones. The bowing or fracture, as the case may be, is always very evident.

Prognosis and treatment may well be combined for they are both very uncertain and equally unsatisfactory. As previously described the fractures may cease at thirty or may continue till midlife. All we can do is to apply splints or casts as necessary to the fractured members or try to avoid slight falls, sudden jars, etc. Medication is apparently of no avail. Various glandular preparations, bone marrow, tonics, etc., have been tried but found useless. So the treatment is merely symptomatic.

Report of a Case.—W. G., age eleven, white, male, born in the United States. Admitted to the Albany Hospital, July 23, 1920, with fracture of the right femur.

Family History.—There is no history of tuberculosis, syphilis, cancer, rheumatism, heart disease, etc. Father is thirty-nine; is well but has pigeon breast. Mother is thirty-seven, well and married seventeen years. Patient has one brother age nine and five sisters, ages six, eleven, thirteen, fourteen, and sixteen. All the children are marked blonds and have blue irides and very light hair. The sister age thirteen has blue sclera and teeth similar to the patient but never has had any fractures. With this exception all of the brothers and sisters are perfectly normal as far as superficial examination goes. The paternal grandfather is alive and well, age seventy-two. The paternal grandmother died at thirty-five due to accident. The maternal grandfather died of rheumatism and heart disease at sixty-five. Maternal grandmother died in childbirth, age unknown. There is no history on either side of the family of fractures or of blue sclera.

Past History.—The patient had measles in infancy but otherwise has been well, except for his fractures, up till last winter when he had diphtheria. However, this was not serious or followed by paralysis.

Fig. 1.—Most recent fracture of femur in case of fragilitas ossium.

The patient was born without instrumental delivery and weighed seven pounds at birth. He began to talk at eighteen months and walked at three years.

History of Fractures.—These began at six weeks of age. The child was being dressed by a relative who in turning him heard a snap and immediately the child began to cry. The next day, because of swelling and pain in the thigh, a doctor was called, and he pronounced the condition a fracture. From this time to the age of one and a half years he had no more fractures, due probably to the extreme carefulness on the part of his parents. Then he commenced to have one fracture as soon as the previous one would heal. These were all located in the femurs and mostly occurred in the right femur. He has had in all thirteen fractures previous to the present, a sudden turn or sharp twist often being enough to cause a new one. A considerable part of his time has been spent in hospitals and at home because of his fractures but of late years he has managed to get to school considerably. In addition to the fractures, there has been considerable bowing of the femurs since he began to walk and thus subjecting them to weight bearing. This is very evident in the accompanying X-ray pictures which in addition to the extensive bowing of the femur show the fracture. (See X-rays.)

The present condition was occasioned by a slight fall which would not have been noticed by a normal child of his years.

Examination of the patient shows him to be a fairly well nourished boy. In stature he is no taller than his six year old sister in spite of his eleven years. His skin is soft, elastic and relatively free from eruptions. He is somewhat pale but looks surprisingly good considering his previous inactivity. Mucous membranes are negative. The sclera are slightly blue. Pupils are equal and react both to light and accommodation. The ears are negative. The teeth are poor and present a peculiar translucency which has been described previously. The gums show considerable neglect being somewhat spongy and bleeding easily. The chest is of the type commonly called pigeon-breast. There is no beading of the ribs or other signs suggestive of rickets. The heart and lungs are essentially negative. The abdomen is negative as are also the genitals and rectum. Small glands are palpable along the posterior borders of the sternocleidomastoid muscles. None are found in the axillary and inguinal regions. Reflexes are normal.

Both femurs present marked external bowing and, in addition, the right presents a fracture with most of the usual signs of fractures, *i.e.*, abnormal mobility, crepitus, deformity, pain, etc. The femurs describe an arc of about 140 degrees. The epiphyses seem relatively larger than the diaphyses.

On admission to the hospital the temperature of the patient was 100 degrees but within a few days was reduced to normal. The pulse remained persistently accelerated, averaging ninety-four all during his stay in the hospital.

Laboratory Examination.

The blood examination was as follows:

Erythrocytes	6,192,000
Leucocytes	17,100
Hæmoglobin (Sahli)	100%
Differential count....Polymorphonuclear neutrophiles	45.1%
Eosinophiles	1.0%
Basophiles	.5%
Small lymphocytes	38.2%
Large lymphocytes	13.2%
Transitional cells	2.0%
	100.0%

The blood urea was 13.2 mg. per 100 c.c.; the blood creatinin was 1.0 mg. per 100 c.c.; the blood sugar was .13%.

The Wassermann reaction was negative.

Examination of a twenty-four hour specimen of the urine gave the following report:—

Color—cloudy lemon; reaction—alkaline.
Sp. gr. 1.008; negative for albumen and sugar.
Microscopically triple and amorphous phosphates were seen with mucous shreds.

The total nitrogen was	4.61 gms.
The total chlorides	1.92 gms.
Uric acid	0.117

A plaster-of-Paris case was applied to the injured member and as soon as the patient could get about on his crutches he was discharged from the hospital. As these cases require a long time to secure firm union, the case has been left on longer than usual for ordinary fracture cases. The medical treatment consisted simply of tonics and laxatives.

The prognosis is fair but with the number of fractures he has already had, rendering him virtually a cripple, the outlook for the future is not very bright.

Since preparing this article, the patient has suffered a new fracture of the opposite femur. It seems his pet kitten was on his lap and suddenly jumped, causing him to twist his leg ever so slightly, but, evidently, the force was sufficient to cause a fracture.

CONCLUSIONS

1. Fragilitas ossium is a relatively rare condition and is accompanied by blue sclera.

2. The etiology is unknown in the large majority of cases, less than ten per cent. being on an hereditary basis.

3. There is no demonstrable relationship between fragilitas ossium and any other bone condition, as scurvy, tuberculosis, syphilis, osteomalacia, etc.

4. The treatment is very unsatisfactory and offers no hope of a cure.

BIBLIOGRAPHY

Harold Burrows—British Medical Journal, July, 1911, p. 16.
W. D. Wise—Journal American Medical Association, Nov., 1918, p. 1696.
Charles Herrman—American Journal Diseases of Children, March, 1915, p. 205.
E. Bronson—Edinburgh Medical Journal, April, 1917, p. 240.
F. A. Conlon—Boston Medical and Surgical Journal, July, 1913, p. 17.
T. R. Whipman—Proceedings Royal Society of Medicine, 1917-1918, p. 68.
W. Hoffman—Archiv für Klinische Chirugie, 1915-1916, p. 229.
J. A. Harvey—Albany Medical Annals, 1918, p. 169.
A. Goldbloom—Journal Canadian Medical Association, 1917, p. 636.

A TECHNIC FOR LEG AMPUTATION*

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of Kansas City, Mo.

An amputation should be done as carefully and with as much thought of future function as a herniorrhaphy or a gastro-enterostomy. Too little emphasis has been placed upon the importance of careful work in this operation. With this in mind I have attempted to perfect a technic that will eliminate as much as possible some of the common complications found in the ordinary amputation stumps, such as tender scars, ulcers and sensitive neuromata. Practically all artificial limb fitters agree that the most satisfactory site for leg amputation is in the middle third. This technic is chiefly for that type of operation, although it may be used higher or lower in the leg or even in the thigh.

Long anterior and short posterior flaps are made (Fig. 1). The long flap is made in order that the scar may be placed in a posterior position to free it from attachment to the bone or from pressure by an artificial limb. In the use of an artificial limb the propelling force of the stump inside of the socket falls on the anterior surface over or near the tibial crest. If there is to be any end bearing, the scar should not be placed on the end of the stump. The most important pressure point in end bearing is, of course, the end of the tibia. In making the anterior flap the deep fascia is included (Fig. 1). This is dissected back at least 3 cm. beyond the point where the tibia is to be divided.

The posterior flap is quite short and is dissected free for a short distance only. From the edge of the posterior flap the skin and fat are dissected downward and a flap of fascia (Fig. 1) freed of sufficient length to turn upward over the cut end of the stump. The muscles are then divided 2 or 3 cm. below the point at which the tibia is to be amputated. The cut muscles are retracted and the tibia and fibula sawed across (Fig. 2). The fibula is cut at least 1 cm. shorter than the tibia. Either before or after the bones are severed the periosteum is carefully removed about the cut ends for a distance of ½ cm. and the marrow is scooped out. The tibial crest is then removed for 2 to 3 cm., so that there will be no sharp points or edges beneath the anterior flap. Sharp or rough edges, if there be any, are made smooth by rongeur or coarse file. The nerves are then carefully freed (there being five chief nerves in the leg), drawn out of the stump as far as possible, and injected with absolute alcohol as recommended by Lewis and Huber [1] (Fig. 3). The nerve is then divided just below the injected point. This prevents the formation of neuromata to a greater extent than any of the other usual methods of nerve end treatment. All

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[1] Lewis and Huber: Archives of Surgery, July, 1920, vol. i, p. 85.

bleeding vessels are then carefully ligated. The entire mass of muscle is grouped together with one strong purse-string chromic suture (Fig. 4), which suture crosses over the anterior beveled portion of the tibia. Additional sutures may be placed when necessary to properly fix the muscles together. If the mass of muscle appears too bulky and is likely to produce a bulbous stump, small portions of it may be excised. The muscles should have been left long enough so that when the purse-string is drawn, the cut end of the bone will be slightly shorter than the muscle. Muscle flaps are not made. The already formed posterior fascial flap (which may have with it some of the thinned-out portion of the calf muscle tendons) is turned forward and sutured over the end of the entire stump as shown in Fig. 5. The sutures placed through the flap reach well into the muscle beneath. This aids in obliterating dead space and giving the muscle a new insertion. The anterior flap is then turned down and the fascia sutured in a few places. This gives two layers of fascia over the end of the bone. The skin is then very carefully closed, shaping the flaps to fit (Fig. 6). A small rubber tube drain is placed beneath the flaps. This is brought out near one end of the wound between stitches. Such drains should always be placed between sutures because healing is more prompt when the drain is withdrawn than if it enters at the end of the wound. A snug dressing is applied for the first twenty-four hours to minimize the oozing beneath the flaps. In the absence of infection some clot beneath the flap is not a disadvantage. It becomes organized and aids in the formation of a fibrous pad over the end of the bones.

After a time a bursa forms over the bone end which aids in the freedom of skin movement. The skin scar is placed so that it will not become adherent to the bone or receive pressure, thus reducing the likelihood of tenderness and ulceration. Muscle flaps are not made, nor is the muscle permitted to extend beyond the end of the bone more than 1 cm., because excess muscle produces an unstable stump end which is likely to become chafed or tender. If any pressure is exerted on muscle covering bone it promptly atrophies and is replaced by fibrous tissue. Muscle is not a normal covering for bone at points where there is weight bearing. On the other hand if the muscle is not fixed at the end of the bone it will retract, leaving bone protruding beneath the skin, which is more likely to become injured or tender than the well-rounded stump end. The above technic fixes the muscle around the end of the tibia with a purse-string and gives it an insertion both at the end of the bone and into the fascia which is sutured over it.

CONCLUSIONS

The advantages of this technic are (1) a firm rounded stump with skin and fascia freely movable over the bone; (2) a scar properly placed so it will not become adherent to bone or receive pressure; (3) no tenderness due to neuromata, chafing or ulceration; (4) the muscles have a new insertion at the end of the stump which prevents their retraction and exposure of the bone beneath the skin.
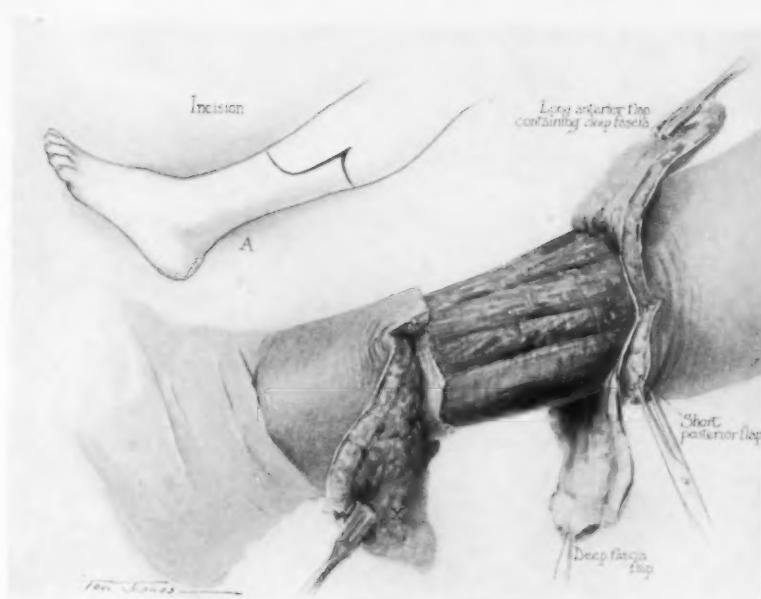
FIG. 1.—Shows incision, skin and fascia flaps.
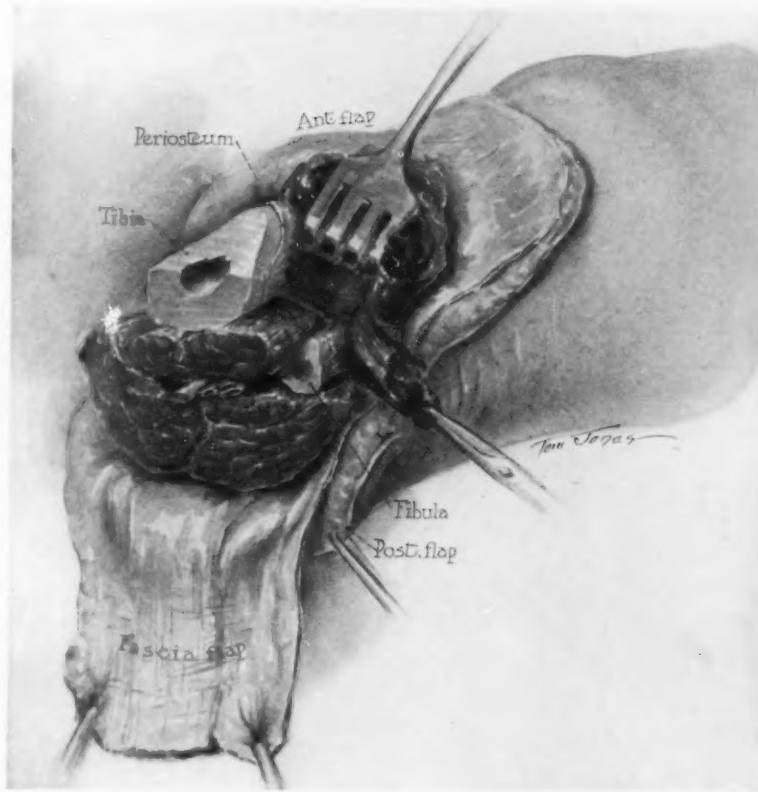
FIG. 2.—Method of treating the bones and muscle. The fibula is cut shorter and the muscle slightly longer than the tibia.

Fig. 3.—Injecting a nerve with absolute alcohol after the method of Lewis and Huber.

Fig. 4.—This shows the muscle grouped about the bones and held together by a heavy purse-string suture.
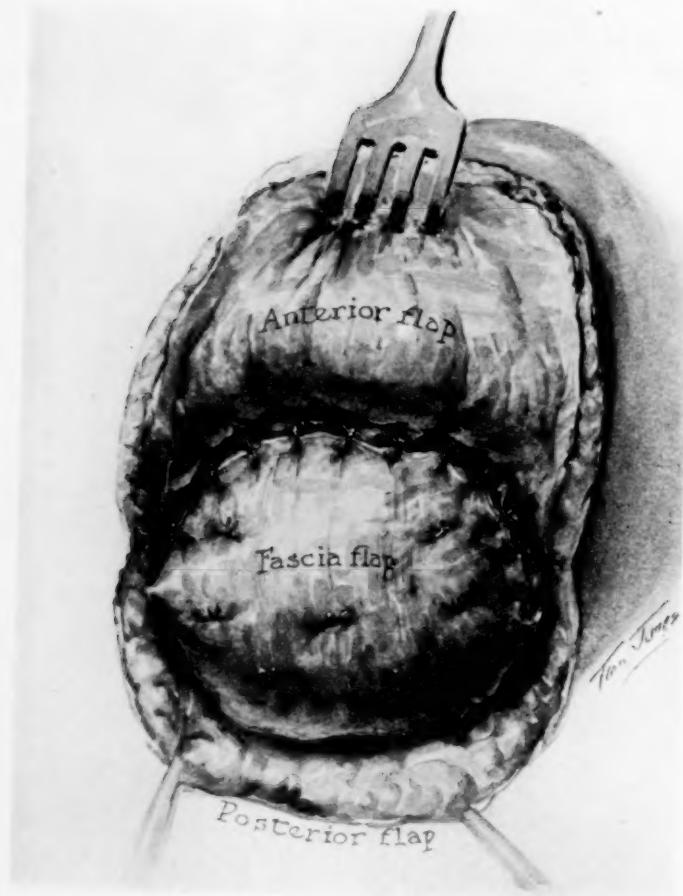
FIG. 5.—Posterior fascial flap sutured over the end of the bone and muscle group. The sutures through this flap reach deep into the cut end of the muscles to fix them firmly to the flap and to obliterate dead space.

FIG. 6.—The finished stump with drain in the posteriorly placed incision.

TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

Stated Meeting Held April 13, 1921

The President, DR. WILLIAM A. DOWNES, in the Chair

GAUCHER SPLEEN

DR. EUGENE H. POOL showed a woman, twenty-six years of age, who presented, first, a Gaucher spleen of unusually large size with little constitutional or blood changes; second, an unusual incision for its removal; third, it showed the advantage of ligating the pedicle before freeing the adhesions and delivering a large spleen. The chief complaint of the patient was a sense of weight in the left lower abdomen, of six months' duration. She also complained of a dull ache in the lower dorsal region and had lost thirteen pounds during this time.

Last August the patient, after a fall on left buttock, developed a tremendous hæmatoma. About this time (September 15, 1920) she miscarried (having been pregnant about six weeks). The patient thinks her abdomen " always larger than it ought to be."

On September 27, 1920, she was operated upon elsewhere for supposed ovarian cyst. The laparotomy disclosed the enlarged spleen. Nothing was done; the abdomen was closed.

Since a child she had noted an abnormal tendency to ecchymosis following slight trauma. Also extensive nose-bleeds which sometimes lasted three or four hours. The blood count January 12, 1921, was as follows: Red blood-cells, 3,800,000; hæmoglobin, 68 per cent.; total white blood-cells, 3400; neutrophiles, 60 per cent.; eosinophiles, 3 per cent.; lymphocytes, 36 per cent.; basophiles, 1 per cent.; platelets, 280,000; anisocytosis, some microcytes, slight poikilocytosis. Wassermann, negative.

Physical examination revealed a mass, evidently the spleen, which reached almost to the right anterior spine and the pubis. Otherwise the physical examination was negative. The patient was well nourished; there was no conjunctival thickening, and no pigmentation of the skin.

January 25, 1921, an incision was made half-way between the umbilicus and the xiphoid, from the costal arch to the midline, cutting through the left rectus and abdominal muscles, then downward to left of the midline at umbilicus to just below umbilicus, thence outward at right angles, crossing the medial portion of the right rectus. This gave admirable exposure and the lower pole of the spleen could be lifted out of the wound. The lower part of the pedicle was lifted carefully and was ligated and cut between ligatures.

This was done for about three inches upward when it was impossible to reach satisfactorily the remainder of the pedicle, due to the fact that the firm adhesions bound the upper part of spleen and prevented its mobilization. These adhesions could not be safely broken. Clamps were placed across them and they were cut through. It was then possible to complete the remainder of the double ligation of the pedicle and the removal of the spleen, which was comparatively easy. There was some hemorrhage, however, from the upper extremity of the pedicle where a vessel had retracted. This was secured and denuded area sutured over. The wound was closed in layers without drainage.

At the end of the operation the anæsthetist called attention to the fact that there were fine petechial spots over the eyelids, conjunctivæ, face and neck and for two inches below the clavicle.

The night before the operation, Doctor Unger had transfused the patient with 500 c.c. of blood (direct method of transfusion). The coagulation time next morning had increased somewhat. At the time of transfusion Doctor Unger called attention to the fact that the tourniquet which had been put on a week before to examine the blood had produced marked ecchymosis. Examination showed a marked ecchymotic ring on the arm at this time (a week after the tourniquet had been applied). Examination of the patient's skin elsewhere showed that slight trauma had produced marked ecchymosis. Inquiry showed that this had been noticed by the patient herself, and the same is said to be true of her sister.

The pathological report by Dr. Ralph Stilman is as follows: The specimen consists of a greatly enlarged spleen with the vessels ligated. It is normal in shape and color and weighs intact 3080 grams. The surface is smooth and glistening and dark bluish red throughout, with the following exceptions: On the external surface near the anterior border is a yellowish area, about 5 cm. in diameter, located 4 cm. from the upper pole. This area is much firmer than the rest of the organ and appears like a thickening of the capsule, which may extend from 1 to 1½ cm. into the organ. It is irregular in outline. In the anterior border about 15 cm. from the upper pole is an indentation filled with yellowish-white firm tissue similar in color and consistence to that described above. These two areas may represent accumulation of scar tissue from an old injury or inflammation. In addition, over the external surface near the lower pole, is a white area about 6 cm. in diameter where the capsule is moderately thickened. A band of adhesions is attached to the internal border near the upper pole. The organ measures 8 x 19 x 35 cm. The consistence of the organ appears to be about normal and the capsule is not under increased tension, although the spleen is well filled with blood. When an incision is made into the capsule, a large amount of dark fluid rapidly escapes. On section the capsule is not thickened and the consistence of the organ appears normal. The cut surface is grayish red in color and smooth, and in it the Malpighian bodies are not visible. The cut surface has a smooth, finely granular appearance, which on close inspection is seen to be made up

of fine grayish points thickly scattered in a background of light red and showing a relatively small number of very fine, very dark red to almost black points. The trabeculæ are not visible.

Microscopic examination showed the characteristics of Gaucher spleen. The venous sinuses are seen to be dilated and filled with large oval or polygonal, faintly staining cells, which have one or two small, somewhat irregular nuclei. These cells show a slightly striated appearance. No cells with more than two nuclei were found. The walls of the venous sinuses are moderately increased in thickness. The pulp cords are compressed. The follicles are few in number, smaller than normal, and show no germinal centres. There is no increase in the fibrous tissue of the spleen. An occasional cell contains granules of material staining with Sudan III.

Doctor Pool stated that the patient had made an uneventful recovery and was now in perfect health.

DR. HOWARD LILIENTHAL stated that he had operated on one case of Gaucher's spleen and had shown the case before the Society and it was recorded in the ANNALS OF SURGERY. This patient had an enormous spleen weighing thirteen pounds, although in the laboratory without its contained blood it weighed but a little more than nine pounds. As the report of the case was published he would not go into it except to call attention to the incision which he used, and which he thought would fit practically every case. This was a sagittal incision just to the left of the midline, up to the costal border and continued to the left, close to the costal border. Through this incision you could secure the pedicle and deliver the spleen. With this incision he had never found it necessary to invade the opposite side. He thought that if he was able to get the enormous spleen out through this incision in this instance, it would fit any spleen.

Doctor Lilienthal said that this case of Gaucher's spleen which Doctor Pool had shown was the first one he had seen that did not show pigmentation. The woman to whom he had referred had generally distributed pigmentation.

DOCTOR DOWNES stated that he thought the procedure of first ligating the pedicle was the correct one when it was possible to do so. This lessened the amount of hemorrhage when the adhesions were separated.

FRACTURE DISLOCATION OF HEAD OF HUMERUS

DOCTOR POOL presented a woman, fifty years of age, who was admitted to the Second Surgical Division of the New York Hospital, March 10, 1919, suffering from a fracture of the head of the right humerus with subcoracoid dislocation.

Two hours before admission she had fallen and struck upon her right shoulder.

The X-ray showed a fracture of the anatomical neck and a subglenoid dislocated head. On March 12, 1919, open reduction was done. Anterior incision beginning at clavicle, curved slightly at the upper end and descending

between deltoid and pectoralis major. Head freed and lifted into glenoid with good reduction. There was a small part of the greater tuberosity attached to the head, though in general the fracture line followed the anatomical neck. This portion, however, gave a good capsular attachment and probably ensured the vitality of the fragment. The upper end of the lower fragment was badly comminuted, the fracture line running along the biceps groove. The capsule was repaired as far as possible and the wound closed without drainage.

At the end of eleven days the splint was removed, position being changed. At sixteen days motion begun. Twenty-one days discharged, no splint. Encouraged to use arm carefully. Patient was then treated in the Out-Patient Department, with baking, massage and manipulation.

All motions are now normal, also the strength of arm. X-ray shows that the head has atrophied only slightly.

Dr. Benjamin T. Tilton said that in cases of fracture-dislocation of the head of the humerus an attempt should be made to reduce the head, provided the fragments were still connected by periosteal attachments. When, however, the head was completely detached and markedly displaced, removal of the head was the best procedure. He recently had had two cases in which the head was displaced into the axilla and could be felt beneath the skin. An incision was made into the axilla and the head removed without difficulty. The functional results in these cases, while very good, were not as perfect as in Doctor Pool's case, where it had been possible to retain the head and start early mobilization.

Dr. F. S. Mathews thought that replacing the head depended largely on the time between injury and operation. In three cases, operated upon by him three to five weeks after injury, it was impossible to replace the head and the glenoid seemed largely obliterated.

Doctor Lilienthal said he had had four of these fracture dislocations and the best result was obtained in one in which he was obliged to remove the head of the humerus. In this case the head of the humerus lay beneath the pectoral muscle and was far from the shaft. . . . He had removed the head and the man had absolutely perfect function two years later. The other day the father of a friend of his had had a fall and sustained a fracture dislocation. His son, being a physician, realized the necessity of early reduction of the dislocation and had an X-ray picture taken immediately. Within twenty or twenty-five minutes they found that it was a fracture of the anatomical neck of the humerus. Later, another picture was taken and further details were ascertained. There was a complete fracture of part of the head of the humerus and the head was split. The head lay with the articular surface pointing out toward the deltoid. Owing to the fact that the man was stout and heavy, it was difficult to reduce the dislocation, but he had succeeded in doing it and now, at the end of two months, the man had very good function, but not as good as in the case in which he had taken out the head. The case in which the head was retained could raise

FIG. 1.—Incision for removal of large Gaucher spleen, about two weeks after operation.

Fig. 2.—Gaucher spleen, gross section.

Fig. 3—Gaucher spleen, microphotograph.

FIG. 4.—Cicatricial contraction of wrist.

FIG. 5.—Hand held in hyperextension by splints after division of palmar contractural tissue and removal of carpal bones.

FIG. 6.—Ultimate result obtained by effort to relieve condition shown in Fig. 4.

FIG. 7.—Amount of flexion possible after operation in case shown in Fig. 4.

the arm to about forty-five degrees without moving the scapula, while the one in which the head was removed had apparently perfect motion in all directions.

CONTRACTURE OF WRIST

DOCTOR POOL presented this patient, fourteen years of age, who was admitted to the New York Hospital, April 14, 1920, for tuberculosis of cervical lymph-nodes and deformity of hand and wrist. He had a cicatricial contracture of right wrist resulting from a burn eleven years previously. Right hand was completely flexed at wrist-joint (Fig. 4). There was very little motion in the fingers. There was also a strong keloidal band at right elbow limiting extension of forearm and a keloid with considerable deformity of lower lip. Operation, April 26, 1920. Transverse incision across anterior aspect of wrist and from this a second incision extending up the crease between palm and thumb. Scar tissue dissected out from the whole adjacent region. The wrist could not be straightened, although the soft parts were not in any way limiting it.

An incision was then made in the midline of the dorsum of the wrist, exposing the extensor tendons and the carpal bones, which were removed. The bones themselves and their relations were markedly abnormal. This wound was closed and the hand was brought up into hyperextension and splinted. Some difficulty, however, was experienced in retaining this position. After operation there was a large open area on the anterior aspect of the hand and wrist. It was planned to graft at once, but no pedunculated graft could be obtained from the vicinity and it was felt that if the part were fixed to the thorax or abdomen the wrist would certainly become flexed. It was decided therefore to defer grafting until the wound had granulated. By an ingenious splint Doctor Dineen retained extension in the wrist and fingers and yet allowed daily flexion. He dressed it with Carrel-Dakin solution, later with ambrine, and epithelialization was so rapid that grafting was not resorted to.

One month after the original operation a plastic was done for the contracture about the right elbow-joint; also a plastic on the lower lip and excision of a submental lymph-node for tuberculosis.

The wrist was treated with baking, massage and electricity for several months, getting good grip and motion in fingers with some flexion and extension of wrist-joint. The photos (Figs. 6 and 7) show the result at its best. Since they were taken some flexion of the wrist has occurred. X-ray seems to indicate that this is due to excessive growth of the epiphyses. Doctor Whitman suggests excision of these and hyperextension which will probably be done.

DR. ROYAL WHITMAN thought that the functional result might be improved by completely reducing the flexion at the wrist. The most effective operation would be to remove the lower extremities of the arm bones which appeared to be hypertrophied. This would destroy the epiphysial cartilage.

As the patient was well developed, the additional shortening would be of slight importance compared with the increased usefulness of the hand.

USE OF CHINOSOL AND SODIUM CHLORIDE AS A FIRST AID

DR. WILLIAM C. LUSK presented a series of patients to demonstrate the value of first-aid disinfection of civil wounds by chinosol and sodium chloride solution. He said that it seemed of significance that, out of a series of twelve experiments on dogs, in which wound pockets constructed in the subcutaneous tissue without blood infiltration, were treated first by filling with certain chinosol-salt solutions (which procedure caused lymphatic infiltration), and then by packing with gauze saturated with the solutions for fifteen minutes, before the scientific infection was instituted (the object being to create a lymphatic block with the disinfectant solution, which should completely envelop the aftercoming bacteria, having used for the infection as much of a virulent culture of staphylococcus aureus as could be absorbed on a piece of gauze about half an inch square, which had been rolled into a wad, placed in the bottom of the wound for half an hour), and then following the scientific infection, by again packing the wounds with gauze saturated with the solutions for fifteen minutes and finally suturing the wounds up tight, in seven instances primary union resulted while the control wounds suppurated with staphylococcus aureus (ANNALS OF SURGERY, May, 1919, p. 493).

It also seemed of significance that, in the case of a sterile wound pocket opened up through a three-inch long incision in the subcutaneous tissue of a dog's back, without blood infiltration, whose lymphatics had been first infiltrated with $\bar{3}i$ of a solution of 2 per cent. chinosol and 0.85 per cent. sodium chloride, which formula was that of the first-aid solution used for the past year and more, and the wound itself then packed with gauze saturated with the same solution, which was left in place for forty-eight hours, at the end of the latter period of time the gauze was found to be no more than slightly damp with moisture, and tightly adherent throughout the wound and was pulled free without causing the slightest hemorrhage, while the surface of the wound had a parched appearance and crinkled when its tissues were picked up with a forceps. The wound was thereupon again washed with the first-aid solution and sutured, the skin having been disinfected again with McDonald's solution before the packing was removed, with resulting primary union.

It seemed of significance that Dr. Alexander O. Gettler, Pathological Chemist to Bellevue Hospital, had found that the chinosol-salt solutions precipitated only a negligible amount of the albumen present in blood serum.

The principles of the first-aid technic, for wounds which came early for disinfection, seemed to be, first, to remove the thin coagulum which forms on the surface of the wound, by wiping the wound with gauze saturated with the first-aid solution (a solution containing 2 per cent. of chinosol and reagent sodium chloride grains 4.1-$\bar{3}i$ or 0.85 per cent.), so as to unstop as much as possible the open mouths of the wounded lymphatics, then to fill the wound,

if it could retain fluid, with the first-aid solution in order to encourage the latter to infiltrate the nearby lymphatics, and, in any case, to sop the wound freely with the solution, applied by means of gauze, with a view of attaining the same purpose. Then, *if the wound were capable of repair*, (1) it might be repaired at once, and closed without drainage, with the expectation of getting primary union, or, (2) it might be packed with gauze saturated with the solution, which should be covered with impervious material, and which could be left in place before repair of the wound was done, for at least as long as fifteen to eighteen hours if necessary, or probably for a good deal longer. In either instance the first-aid solution should be used freely in the wound during the operation for repair, and the wound closed without drainage. If the effectual action of chinosol in wound disinfection were due to its stimulation of phagocytosis, as seemed likely, since *in vitro* chinosol was but little bactericidal, drainage would only impede this physiological process. *If the wound were not capable of repair,* it should be treated open, being filled with gauze saturated with the first-aid chinosol-sodium chloride solution, which dressing might be removed once a day, or, if the gauze became adherent, then after a longer interval.

In the case of traumatic wounds widely contaminated with foreign material, as wounds of war, *which came late for first-aid disinfection,* at a time when the implanted bacteria had begun to multiply, it seemed to be a question whether it would be desirable to attempt more than a mechanical cleansing of the wound, and packing of the same with gauze saturated with the first-aid chinosol-sodium chloride solution, omitting any attempt to infiltrate the lymphatics with the latter, lest the attainment of such purpose might then become a means of spreading the infection, as had occurred in a number of freshly made experimental wound pockets in dogs, in which the scientific infection had preceded the infiltration of the lymphatics with the disinfectant solutions, suppuration which extended to a distance from the original wound having frequently resulted.

CASE I.—W. J. McI., aged twenty-eight. *Incised wound of nose and cheek*. Admitted to Bellevue Hospital December 12, 1920. The incision cut obliquely through the left nostril, passing in the median line just above the tip of the nose, entering the right nostril and completely severing the nasal septum, then, cutting through the junction of the right ala with the cheek, it passed backward and a little downward across the right cheek for a distance of about four inches, at which latter situation it was about three-quarters inch deep. There had been free hemorrhage into the wound from a severed facial artery. There was no evidence of iodine having been used. On admission, after arresting the hemorrhage and wiping the skin with the solution of Dr. Ellice McDonald (alcohol sixty parts, acetone forty parts, to which mixture 2 per cent. of pyxol is added) [McDonald, Ellice: *Journ. Amer. Med. Assn.*, February 7, 1915, vol. lxiv, p. 505, and *Surgery, Gynecology and*

Obstetrics, July, 1915, pp. 82–86], the solution of 2 per cent. chinosol and sodium chloride, grs. 4.1–ʒi, was poured into the wounds, which were then packed with gauze, saturated with the same solution, and this dressing was covered with rubber tissue.

Nine hours later the wound was examined and redressed as before, and one hour afterward was repaired. The tissues of the wound had preserved a perfectly fresh appearance and showed no chinosol staining. (The first-aid solution may combine with infiltrated blood to produce a gray or black stain of the tissues, which does not interfere with primary healing in a sterile wound.) Skin preparation was first by wiping with peroxide of hydrogen and then with ether to remove the blood clots, etc., then, for disinfection, by wiping with McDonald's solution. The wounds were wiped and sopped with the first-aid chinosol-sodium chloride solution, and the latter was poured into the wound of the cheek and used freely in the wounds during the operation for repair. Three deep catgut sutures approximated the fat of the cheek, while the skin was sutured with horse-hair. The sutures in the nose, which were deeply placed, did not bring the skin edges evenly together. The nostrils were packed with gauze wet with the first-aid solution and the stitch-line was covered with the same dressing, having rubber tissue superimposed. The wounds were dressed daily as above. The highest temperature following operation was 100 degrees. A primary swelling of the cheek reduced rapidly (fourth day). With the exception of two slight openings in the suture line of the cheek wound, from which a few drops of serum discharged on the second, third and fourth days, and a little ulceration along three or four stitches in the same wound, which were mere tacks in the skin edges, primary union took place throughout. The ragged line of union in the nose under the wet dressing with the first-aid solution, applied once daily, rapidly cicatrized and skinned over. The patient was discharged from the hospital on the eighth day, he returning for a few more dressings of the wound of the nose.

CASE II.—J. B., age twenty-four. *Incised wounds of neck, pinna and face.* Admitted to Bellevue Hospital December 27, 1920. Transverse incised wound of back of neck, about one inch below level of occiput and about four and a half inches long, extending from just behind the right ear to the left of the median line, cutting across the ligamentum nuchæ and completely through the adjoining one and a half inches of the right trapezius muscle. Also, in the same line, the right pinna was entirely cut through and there was a superficial incised wound of the right cheek about one and a half inches long. No iodin or other chemical had been used in the wounds prior to admission. A nicked occipital artery had bled freely into the wound. Though the skin around the wound had been wiped early with McDonald's solution, the hair of the scalp was not shaved until just before the operation. The wounds were washed with the solution of 2 per cent. chinosol and sodium chloride, grs. 4.1-ʒi, and then packed with gauze saturated with the same solution. Twelve hours later the wounds were examined. That of the neck was filled with the first-aid solution and all the wounds

were repacked with gauze saturated with the same solution, over-lapping the skin edges.

Operation for repair thirty-one hours after the first-aid solution had first been used in the wounds. The wounded tissues at this time were fresh and moist and normal in color, and without a particle of chinosol staining. The skin was cleansed of its blood stains by wiping with peroxide of hydrogen and afterward with ether, was shaved and then disinfected with McDonald's solution. The first-aid chinosol-sodium-chloride solution was used freely in the wounds. The wound of the trapezius was sutured with interrupted chromic sutures, the skin of the neck with silkworm gut and the wounds of the ear and face with horse-hair. The wounds were dressed with gauze wet with the first-aid solution, which was covered with rubber tissue. Uneventful recovery. Primary union throughout.

CASE III.—T. L. O'D. Electrician. Age about twenty-two. This case illustrates the open first-aid treatment of wounds unsuitable for primary repair. It was one of *high compound fracture of the leg with gangrene of the foot,* in which suppuration did not occur in the wound, treated open with the first-aid chinosol-sodium chloride solution then in use (chinosol, grs. iv-ʒi, and normal sodium chloride), so that it was possible on the fifth day to amputate at the seat of fracture and ultimately to save the knee-joint.

On March 12, 1919, the patient was admitted to Bellevue Hospital after having sustained a compound fracture of the left leg about four inches below the knee-joint, with much laceration of the soft parts, there having been a widely separated wound anteriorly, and the finger passed backward between the bony fragments, entering an area of deep laceration behind the seat of fracture. The foot was lifeless. There had been no iodin or other chemical introduced into this wound prior to the first-aid dressing with gauze saturated with a solution of chinosol, grs. iv-ʒi, and 0.85 per cent. sodium chloride, the first-aid solution in use at that time, which was laid in the interior of the entire lacerated area, having been introduced through the seat of fracture, into the wounded soft parts behind. Two strips of gauze, introduced at the first dressing, became so tightly adherent in the deep wound that they could not be readily detached until the fourth day. When removed they were odorless. The wound was dressed once daily. On the second day, all the gauze that was detachable was removed, the wound cavity was filled with the first-aid solution and fresh gauze wet with the latter was introduced. On the third day, all loose pieces of gauze were removed. Some of the gauze applied to the superficial wound on the preceding day had become adherent. The gauze withdrawn was perfectly sweet and there was no pus in the wound. The deep wound was now filled with the first-aid solution and gauze wet with the latter was simply laid over the superficial wound and was covered with rubber tissue. The temperature was not over 100.4° until the fourth day, when it rose to 102°. On the fifth day amputation of the leg was performed, which was done through the seat of fracture, making a long

posterior flap, including muscle which was the seat of thrombi, though the posterior tibial artery in the flap pulsated. A personal note on the operation stated: " The wound contained a little serosanguinolent discharge." Following the amputation, the interior of the wound sloughed, and to facilitate the removal of the sloughs, gauze saturated with a solution of 2 per cent. chinosol and 5 per cent. sodium chloride, was applied to the wound once daily. (Caution was recommended in the use of the latter strongly hypertonic solution on tissues affected by senile or trophic changes.) On the eleventh day post-operative, a slough of the calf muscle, half the size of a fist, had almost separated and was removed by cutting a few remaining attachments. On the fourteenth day, after finally washing the wound, which was now practically free from sloughs, with the same solution, the posterior skin flap was laid forward against the granulating surface behind the tibia and a compress applied, and on the following day the apposed tissues had adhered nearly everywhere. The tibial fragment protruded.

On April 23rd reamputation was performed, the line of dividing the bones being through the lower portion of the tubercle of the tibia and through the middle of the head of the fibula. A solution of 2 per cent. chinosol and 0.85 per cent. sodium chloride was used in the wound during the operation. The wound was closed with drainage and primary union occurred in all of the apposed tissues and the drain sinuses rapidly closed. The middle of August, 1919, the patient began wearing an artificial leg. Three months later he stated that his artificial leg had never given him any trouble, that his stump had never swelled and that he was on his feet all day long. Since then the patient has had no trouble, climbing ladders with ease in the routine of his work.

DOCTOR LUSK said that he believed this open first-aid treatment would be applicable as well to the *wounds of war,* in which a gauze packing, saturated with the first-aid solution (2 per cent. chinosol and sodium chloride, grs. 4.1-$\mathfrak{z}$i), and covered with impervious material, at least could be expected to arrest bacterial growth and prevent decomposition for a considerable period of time.

The first-aid solution was made with *cold* sterile distilled water, in which 2 per cent. of chinosol powder should first be dissolved, and then *reagent* sodium chloride, grs. 4.1 to the ounce (0.85 per cent.), which should be added in bulk. In making up this solution the glass receptacles and utensils should first be scoured with neutral sodium oleate and then boiled in plain water. An alkali would precipitate oxyquinolin from the chinosol (oxyquinolin sulphate), so that soda should not be put into the water used for boiling. A glass vessel was preferable to an enamelled one as a container, since spots of bare iron usually present in the latter receptacle, would discolor the chinosol.

The addition of the sodium chloride to the chinosol in solution, changed the microscopic picture of the crystallization of the chinosol and was believed

to render the latter little liable to irritate. A solution of 2 per cent. chinosol in combination with normal sodium chloride had seemed liable to irritate only from too oft repeated applications daily, or from a too long-continued use of the applications once daily on gauze left *in situ* between dressings, in the latter instance the skin alone being usually affected, the wound apparently being protected by dilution of the solution with a sufficient amount of secretion. The solution on first coming into contact with a wound caused a burning sensation for a few moments. The " reagent " sodium chloride had seemed to produce more completely the changes in the crystallization of the chinosol than had less pure varieties of sodium chloride. Boiling of the sodium chloride had seemed to produce salt cubes, as seen under the microscope in the crystallized specimen, generally larger in size and fewer in number than when the sodium chloride was added to the solution without boiling, the finer subdivision of the cubes of the unboiled product apparently acting more widely throughout the solution to cause the change in the crystallization of the chinosol. The chinosol-salt solutions should not be boiled, since when boiled they caused a greatly intensified burning sensation in the wounds and had seemed liable to produce a superficial tissue necrosis.

Grains xxiv of chinosol in solution had been infiltrated into the lymphatics around a sterile subcutaneous wound pocket, free from blood infiltration, in the back of a dog weighing 8 kilos, with primary union in the sutured wound and without subsequent ill effects.

DR. ROBERT T. MORRIS asked Doctor Lusk whether the use of the isotonic saline solution allowed him to use a stronger chinosol solution without causing irritation than would be possible otherwise. He stated that he used chinosol solution in about the same proportion as bichloride of mercury. Used in that way, he found that a 2 per cent. solution of chinosol was sometimes irritating, and he had depended chiefly upon less than 1 per cent. in solution without salt. It was one of the best antiseptics for all around convenience.

DOCTOR LUSK, in answer to Doctor Morris' question, said he believed that the addition of the sodium chloride in normal strength to a solution of 2 per cent. chinosol, which changed the form of crystallization of the latter, made the solution of this strength of chinosol less liable to cause irritation. In the first-aid treatment of fresh traumatic wounds as described, the speaker had seen no evidence of chinosol irritation. Where sterilization of abscess cavities was sought by the daily introduction into them of a gauze packing saturated with the first-aid solution, left in place between daily dressings, wound or skin irritation had not been seen. In general terms, a sufficient amount of wound secretion had seemed to be protective against the production of wound or skin irritation as a result of the application of the solution of 2 per cent. chinosol and normal sodium chloride on gauze left in place between daily dressings, and where the wound secretion was ample, it had seemed that this wet dressing could, as well, be confined beneath an impervious covering with impunity. In the case of small wounds without much secretion, an external dressing saturated with the first-aid solution, renewed

once a day, might, after a little while, irritate the skin, it being particularly liable to do so when confined beneath an impervious covering, which latter should generally not be used on these cases. At the same time, a first-aid wet dressing applied once a day to an illy-apposed suture line, had, in a number of instances, caused rapid healing of the ragged edges. But two wounds, ones of long standing, had seemed to have become irritated from the application of the first-aid solution once daily, to one of them (thrombo-angiitis) the application having been made for only a short period of time each day, in the other, the packing wet with the solution having been retained between daily dressings over a considerable period of time, and each discharging but little secretion. Granulating wounds with but little secretion had sometimes been syringed with normal saline before packing them with gauze wet with the first-aid solution, which technic had seemed to be favorable to healing.

CARCINOMA OF THE RECTUM

DR. HUGH AUCHINCLOSS presented two methods of dealing with rectal anastomoses after removal of carcinomata. The carcinoma was four and a half inches above the anus in one, and at the promontory of the sacrum in the other. Both were "high" cases. If one classified cancer of rectum cases as high, low, and medium, these would be medium and high.

Low cases, within two or three inches of the anus, are best dealt with by a colostomy. Occasional cases remain well in this group after having had an anastomosis done, but it is pretty generally conceded that the colostomy and complete removal of rectum is safest.

The middle group is where an anastomosis can be effected, though done with difficulty because of the shortness of the anal segment.

The high group is where sufficient anal segment has been left to allow of an anastomosis through the abdomen.

The blind procedure of removing a carcinoma of the rectum entirely from below without knowing whether metastases exist above is falling rightly more and more into disrepute.

CASE I.—G. S., male, thirty-five years of age, single. Ship steward, Swede, M. U. S. fifteen years. The previous and family history were irrelevant. Admitted to Presbyterian Hospital August 25, 1919. Entered U. S. Army February, 1918, *i.e.*, eighteen months previously. Eight months ago fell two flights to a stone pavement; couldn't walk for a month; in bed, bruised and strained lower back. At same time began to have diarrhœa, cramps and colic. Six months ago bleeding from rectum. Four months ago constipation, pain in sacral region, and at about this time was discharged from the Army. Some loss of strength. Lost ten pounds. No vomiting nor bladder symptom.

Proctoscope and Digital Examination.—Hard, nodular, ulcerating growth of characteristic cauliflower appearance involving anterior wall, most of left and a little of right sides of rectum, four and a half inches

above anus. Specimen removed, reported carcinoma of rectum. Operation September 3, 1919.

Pathology of growth as described in examination, free from bladder, and covered by peritoneum except posteriorly, where mesorectum broadens out to either side. Mesosigmoid was short and sigmoid also. No evidence of metastases, lymph-node nor liver.

Procedure: Median incision below umbilicus. Superior hemorrhoidal clamped close to inferior mesenteric and half the sigmoid removed and oral end inverted with a purse string, the ends of which were long and threaded through the loop in a probe. The rectum was then freed well below the growth and a heavy silk ligature tied about the rectum an inch below the growth. With the patient in lithotomy position, Doctors Burnap and Hanford, who were good enough to assist me, working from below dilated the sphincter and washed the rectum clean as far as where the ligature had been placed below the growth, preventing fæces and blood from the ulcerating carcinoma from running down. They then introduced a glass, Ferguson, cylindrical speculum almost to where the ligature had been placed. Eight long five-inch needles, that had been specially made for this purpose, threaded on either end of silk sutures, were then passed, interlocking as chain sutures, two needles close together at each of the four quadrants of the gut circumference, about an inch below the ligature through the wall of the gut from above, into the speculum in the interior of the rectum below and drawn out of the anus. Traction on all these ligatures pulled the wall of the rectum over the edge of the speculum. The gut was then divided by the operator above, about two inches below the growth and one inch below the ligature, and the growth, one-half of the sigmoid and upper two-thirds of the rectum removed. By pulling the traction sutures the lower anal segment was then turned inside out into the speculum and the speculum and anal segment drawn out of the anus. Some confusion occurred here because the sutures had not been kept in the four quadrants to which each pair belonged.

The probe attached to the purse string about the end of the oral segment was then passed through the lower anal segment that had been turned inside out, and the oral segment, namely, upper sigmoid, which previously had been mobilized further by dividing the outer leaf of the peritoneum over the descending colon, drawn through for about six inches. Anastomosis was then done with interrupted chromic sutures and a tube introduced through the sigmoid to just above the anastomoses. The sigmoid, and " turned inside out," telescoped, lower segment was pushed back through sphincter, leaving some of sigmoid and the tube protruding. A lateral incision into ischiorectal space posteriorly and along the coccyx was made for drainage.

Pathological report, carcinoma of rectum.

Seven days later developed a fecal fistula—tube and sigmoid slough removed on ninth day. Bowels moving, however, through anus. Twenty-eighth day fistula almost closed. Discharged forty-second day to Burk's Foundation. Stayed there ninety-two days, being employed

most of the time as one of their cottage leaders. Fistula entirely closed. Shortly after discharged from the hospital.

There have been forty follow-up observations since discharge up to the present. Proctoscopic examination has been done repeatedly by Doctor Yeomans. His bowels move satisfactorily according to his diet and he is now taking a course in vocational training and seems quite well. There is a slight weakness of the lower end of the median incision where the drainage tract and fistula was situated, but the mucosa of the rectum shows no evidence of recurrence and only moderate constriction.

Case II.—M. F., female. Ireland. Age fifty. Admitted to Presbyterian Hospital March 7, 1919. History: Double öophorectomy thirty years ago at Woman's Hospital. Recent loss of weight of thirteen pounds. Slight amount of blood in stool several months ago. Thought she had hemorrhoids. Since then stools occasionally " almost black." Feels strong and well. Bowels have been moving regularly; no diarrhœa. Comes to hospital because one week ago she had an acute attack of " inflammation of the bowels," with gas, colicky pains, and maximum " soreness " and tenderness in left lower quadrant radiating to her back. Nauseated, but couldn't vomit. Slight febrile reaction.

Examination: Well-nourished woman not appearing ill, with a median scar below umbilicus from old operation. In left lower quadrant just to left of promontory there seemed to be a mass that was very slightly movable and a little tender. No visible peristalsis, no mass felt by rectum. Proctoscope could not be passed beyond ten inches and no abnormality of mucosa made out at that point.

It was only after three X-ray examinations that a filling defect was defined at the junction of rectum with sigmoid. Gallstone shadow definitely shown. The diagnosis of carcinoma of pelvic colon was made, having in mind a diverticulitis or ileus from a peritoneal or omental band, a sequel to former operation. She also was thought to have chronic cholecystitis, cholelithiasis, calculus in gall-bladder. Operation March 31, 1919.

Pathology: A large mass, evidently an annular carcinoma of the colon at the junction of the rectum and sigmoid, lay just to the left of the sacral promontory at the brim of the pelvis. There were peritoneal adhesions binding two loops of small intestine to the growth. Evidently a recent localized peritonitis had occurred about the growth. The sigmoid was only moderately distended, whereas the rectum below the growth was very markedly distended, a feature not uncommon in such a case.

Procedure: The small gut was carefully dissected free from the growth. The mesentery was ligated off and growth and about 8 cm. of gut above and about the same amount below removed in following manner. Four crushing clamps were placed above and below, and gut divided between them with a cautery. The cauterized ends were then placed end to end, and rolled away from one another so that two continuous crushing sutures of silk could be placed, uniting the serous

surfaces of the two segments for half their circumferences. The clamps containing the cauterized ends were then rotated over so as to bring the other halves of the gut circumferences together, and the two already placed sutures complete the gut circumference back to the point they started from. The clamps were then loosened and slipped off and the sutures tied, first the inner layer, then the outer layer, thus completing the anastomosis. The closure seemed quite complete, and fingers could readily be approximated on invaginating the gut wall from above and below. Rubber tube drains were placed alongside the anastomosis into the pelvis. A rectal tube was left in rectum temporarily, in case there should be any bleeding from mucosa edges.

Post-operative course: This was unexpectedly smooth. There was no fecal leakage at any time, no hemorrhage; temperature 101° on second and fourth days and below 100° at all other times; pulse never above 100 after operation. She was discharged April 30, 1919, on her thirtieth day after operation, with only a tiny granulating spot that readily closed.

Follow-up notes: Twenty-nine reports have been made and to-night makes the thirtieth time I have seen her during the period of two years since the operation. She has been proctoscoped twelve times. The proctoscope passes through the anastomosis, which appears as a slightly paler portion of the mucosa, readily into the sigmoid. The rather conspicuous absence of stricture is worth consideration. On March 22nd she weighed 131½ pounds, which is more than she has weighed at any time since her operation; her bowels move readily, and as far as we can tell she seems perfectly well.

This is the first time he had used this method for an end-to-end anastomosis of the large gut, though he had used it a few times for end-to-side ileocolostomies. It has never been associated with hemorrhage. It is the cleanest anastomosis I know of that works. Furthermore, it is simple. He first saw it used by Doctor Blake several years ago in an ileocolostomy, end-to-side, following resection of carcinoma of cæcum. The method is not original. The purpose of showing the case is to call attention to the method for large intestinal anastomosis where scrupulous asepsis is of such prime importance.

Doctor Hartwell said that the second case looked as though the carcinoma had been situated only about two inches above the line of section of the rectum. He had always felt that if a carcinoma was low enough to be reached by the palpating finger no one could predicate a cure by end-to-end anastomosis. This boy seemed to be cured at the present time and he might remain free from recurrence. It seemed to him that to leave the amount of rectum necessary in order to have the sphincter function was sometimes a dangerous procedure. Of course that did not apply to a growth situated higher up. One or two cases in which a low end-to-end anastomosis had been done showed a long period of cure, but a number of cases collected showed a large percentage of recurrences at the site of the anastomosis. Doctor Hartwell said he had come to believe that if a cancer lay below the

peritoneal reflexion it was better to sacrifice the lower segment of bowel and to make an artificial anus.

DOCTOR AUCHINCLOSS rejoined that these growths were above the peritoneal reflexion. In the second case when the bowel was pushed down, one could barely palpate the lower margin. He had seen a patient who had an extensive growth with involvement of the lymph-nodes in 1913. In this instance the growth was not over an inch above the anus and the patient was well to-day. However, he agreed that the lower growths had better be taken out with the sphincter. These two growths were both high growths. He had used this method of anastomosis with clamps for end-to-side anastomosis. Small gut into large in resection of cæcum. With this method one did as nearly as possible an aseptic operation. The only mucosa exposed was that that had been cauterized. This was the only case in which he had done an end-to-end anastomosis of the large intestine by this method. No leakage following operation and no stricture two years later in this case give hope it may prove useful in others.

LUMBAR HERNIA

DOCTOR COLEY showed a man, aged twenty-five years, suffering from a double lumbar hernia. He had served in the United States Navy in the late war, and gave a history of having had a hernia just between the iliac crest and the costal arch on both sides for some years, which only recently began to give him trouble. The bulging was more noticeable on standing or lifting, and violent exercise of any kind caused considerable pain. He was admitted to the Hospital for Ruptured and Crippled in 1919, where Doctor Coley operated on the left side, which was a little larger than the right. The operation consisted of a three and a half inch oblique incision, one and a half inches above the crest of the ilium, extending back to quadratus lumborum; no sac was found, the peritoneum was not opened and closure was made by overlapping the suprapubic layers of muscles. The opening through which the protrusion occurred was apparently located in the space known as the triangle of Petit. The patient reported for duty three weeks after leaving the hospital, and had to sleep in a hammock, where he was tossed about. A recurrence of the hernia developed and it is now nearly as large as the hernia on the other side. At the present time there is a distinct bulging through Petit's triangle, which, as you know, is situated between the outer border of the latissimus, the posterior border of the external oblique, and the crest of the ilium. Doctor Coley remarked that this type of hernia is extremely rare, the latest study of the subject having been made by Goodman and Speese (ANNALS OF SURGERY, May, 1916), who reported one case in a man, fifty-eight years of age, in which on account of a coexisting nephritis no operation was performed. They were able to collect thirty-three cases of lumbar hernia from the literature.

This type of hernia was apparently known as early as the latter part of

the seventeenth century, but no careful observation was recorded until that of Garangeot in 1731. In 1768 Balin writes: "Lumbar hernia may arise unexpectedly between the false ribs and the crest of the ilium." A few years later, Petit described the same place in a little more detail, and to him the credit is generally given for the discovery of this triangle known as Petit's triangle. Grynfeltt, in 1856, describes the place still more fully. Grynfeltt's space is a little different from Petit's; it is bounded above by the twelfth rib, internally by the quadratus lumborum, externally by the external oblique and below by the internal oblique muscle. Four years later, Lesshaft, without mentioning Grynfeltt's work, described the same space, and it is generally known in Germany as Lesshaft's triangle. (For a full description of the condition, see Goodman and Speese's original article in the ANNALS OF SURGERY, May, 1916.)

Of the thirty-three cases collected by Goodman and Speese, intestinal obstruction with strangulation occurred eight times, or in 24 per cent. of the cases. In nineteen cases the hernia was on the left side, and in ten on the right; only two were bilateral. It was much more common in adult males, having been observed twenty-two times, and only nine times in females.

Doctor Coley stated that as far as he knew only two cases had been observed at the Hospital for Ruptured and Crippled, one a girl, aged eight years, who was operated upon by Doctor Bull and Doctor Coley in the early 90's; patient made a good recovery and was without recurrence for many years after. The present case is the only case of bilateral lumbar hernia that they had ever observed, and apparently only two other cases have been found in the literature. Goodman and Speese state that indirect traumatism is an important causative agent, a history of sudden strain, lifting of heavy weights, and coughing, has been noticed in fourteen of the thirty-three cases. As regards the age of their patients only five occurred before the fortieth year. Both of the cases observed by Doctor Coley occurred in patients under thirty years of age. In most of the cases mentioned no sac has been found either at operation or autopsy.

DR. ALEXIS MOSCHCOWITZ stated that he had examined the patient only hastily, but as thoroughly as it was possible for him to do at this time, and he could not quite see where this hernia came through. As a matter of fact, without wishing to doubt the diagnosis in the slightest degree, he must say, that he did not understand the method by which the diagnosis was arrived at. Cases of this nature are exceedingly rare, but from a study of the literature, he was under the impression that of all hernias in this region those that passed through the triangle of Petit are the rarest; indeed the occurrence of this particular variety was a matter of doubt, an authentic and well-studied case was, however, reported a few years ago by Dowd in the ANNALS OF SURGERY. Those hernias which pass through the space of Greenfelt and of Lesshaft appear to be somewhat more frequent, though by no means common. Doctor Moschcowitz would not wish to express any definite opinion as to the case

presented by Doctor Coley, after the meagre examination that he was able to make.

DOCTOR COLEY rejoined that hernia of this region had not always been accurately classified, it having been the custom to include under the name of lumbar hernia all hernias occurring between the crest of the ilium and the twelfth rib. Possibly they did not all come out at the triangle of Petit. Doctor Coley stated that in the present case he believed the hernia to emerge at or near Petit's triangle, for if the hand were placed over this space, the swelling did not appear. After emerging, it passed inwards and downwards so that the swelling was slightly more anterior than in the cases observed by Goodman and Speese. Doctor Coley believed these hernias were properly classed as lumbar hernia. He said he should like to ask Doctor Moschcowitz through what opening the hernia did come out if not through the triangle of Petit. Doctor Moschcowitz stated that he did not know. Doctor Coley added that there was a bulging through the whole area at the site of both Petit's triangle and Grynfeltt's space. It was not always easy without operation to give the exact anatomical location.

THE MANAGEMENT OF PELVIC ABSCESS IN ACUTE APPENDICITIS

DR. ELLSWORTH ELIOT, JR., read a paper with the above title.

DR. ALEXIS MOSCHCOWITZ said that he was glad to hear that Doctor Eliot does not advocate the drainage of pelvic abscesses through the rectum or vagina, at the time of the primary operation. Doctor Moschcowitz has found that it is not only feasible, but perfectly safe and simple to drain these abscesses through the incision which is made for the extirpation of the appendix. He uses as drainage material always a good-sized drainage tube, with a wick of gauze in its lumen. This wick of gauze is removed at the end of twenty-four or forty-eight hours. If there are two widely separated collections of pus two drainage tubes are used. The after-treatment differs somewhat from that advocated by Doctor Eliot. He has abandoned all irrigations, after an experience many years ago, at which a fatal peritonitis developed after a gentle irrigation through a catheter. The method he now uses is, that the drainage tube is cleansed by passing into it repeatedly wicks of gauze until perfectly dry; this is done at each dressing, usually once a day. When the discharge assumes a more serous character, the tube is shortened by one-half to one inch, until removed completely. With this method of after-treatment his results have been most satisfactory, most patients being discharged with a healed wound in two weeks' time.

In very rare instances, more especially in some cases of diffuse peritonitis, late residual abscesses form, e.g., in the subphrenic space, in the left iliac fossa, or in the splenic region, and require separate incisions. If they occur in the pelvis they are drained either through the vagina or through the rectum, but never as a primary procedure.

DOCTOR HARTWELL said he used a double soft drain or a cigarette drain. He left it in forty-eight hours.

DR. WILLY MEYER recalled that about ten years ago the question came up whether surgeons should close the abdomen without drainage after appendectomy in cases where a pelvic abscess or multilocular effusion of infected fluid had been found subsequent to acute gangrene, the latter not having passed from the appendix to the cæcum. Many tried this method and closed the wound, and while it was successful in a good many cases it had been given up as uncertain and drainage generally employed. One could not determine always how far the gangrene had actually extended. He used the pararectal incision and was still using Morris's cigarette drain with a central tube. He sometimes added a rubber tube split lengthwise after all the pus had been evacuated. Personally, he never used irrigation but he always added post-operative posture treatment, using the pronounced Sims posture combined with the Fowler position. After the first three days a slight Trendelenburg posture was resorted to.

In operating upon an acute case he believed it was an unwise procedure to make an abdominal incision with a vaginal or rectal incision. One certainly could reach a deep-seated abscess through the abdominal incision; but if a pelvic abscess developed slowly following an acute attack of appendicitis, say eight to ten days after, without perityphlitic inflammation and swelling, one could make the diagnosis by rectal or vaginal palpation and then evacuate the abscess through the rectum.

DR. WM. T. LUSK said it had been scientifically shown on rabbits by Petroff, of Warschau (*Centralblatt f. Chir.*, No. 31, 1913, p. 1215), that glass drains with wicks were the best for peritoneal drainage, since adhesions were very slow to form around glass, and a drain of this sort would continue to abstract fluid out of the general peritoneal cavity for more than forty-eight hours, while gauze was effectual to drain for only five to six hours. He thought that in acute general peritonitis, pelvic drainage was best effected by the old-fashioned glass drain with multiple perforations in it, threaded with a gauze wick to the bottom. In the Fowler position, the lumbar spine should be arched well forward in order to empty fluid collections out of the kidney fossæ into the pelvic cavity, which posture seemed to be best effected by the lateral upright position of the patient, once recommended by Dr. Willy Meyer.

DOCTOR LILIENTHAL said that when one drained a pelvic abscess through the abdominal incision he must be careful that the tube did not get among the coils of small intestine. It should be kept near the abdominal or pelvic wall, thus minimizing the danger of secondary obstruction.

Another point Doctor Lilienthal said he would like to bring out was that one could irrigate in a manner during the course of healing. He referred to the Carrel treatment of the abscess. He had found this of enormous value. It made for the comfort of the patient, for the cleanliness of the wound, and took away the odor. It would not, however, dissolve sloughs, which would have to be removed, when cast off, by other means.

In the matter of putting in the drainage tube, if it came out and one lost the track in putting it back by the probe method, Doctor Lilienthal said he had an exceedingly satisfactory method. It did not cause the slightest pain, was absolutely free from danger and assured one of getting the tube to the bottom of the cavity. He used an ordinary endoscopic tube. This was a rough, smooth, straight instrument which could be wormed into a tortuous tract straightening it out. It could be used to enter a recent sinus up into a subphrenic abscess or down into the pelvis. The patient would not feel the entrance of the instrument. When the endoscope was in place the drainage tube could be introduced through it and the endoscope removed.

DR. ROBT. T. MORRIS emphasized the point that pus took the line of least resistance. We did not need a counter-incision. We owed it to the patient to give him the least attack of surgery possible in the course of appendicitis with abscess. This would belong to the fourth era in surgery, placing chief dependence upon the patient's own protective resources. After Doctor Clark published a report upon a hundred cases of pyosalpinx closed without drainage, Doctor Morris had closed the abdomen in a series of appendicitis cases without drainage and he found that nothing was lost. Nevertheless, he felt that it was best to drain through a small incision, using a flexible wick drain as small or as large as was necessary, depending upon the size of the patient and the actual mechanics of the situation.

As for the matter of flushing, Doctor Morris said he had never found flushing necessary so far as recovery was concerned, either at the time of operation or subsequently. It was objectionable at the time of operation. It might have a value in making the patient more comfortable as far as the question of odor was concerned as a post-operative bit of neatness.

DR. WILLIAM A. DOWNES described a drain which he had found very satisfactory. This consisted of a sheet of rubber dam about the size of a sheet of paper, folded loosely, and introduced to the base of the abscess. This drain was not removed, but was allowed to work itself out; this usually happened by the end of the eighth or tenth day. The wound healed well with this kind of a drain and the patient was usually discharged by the eighteenth day with only a small granulating wound remaining. Since using this drain, he seldom had occasion to worry about the formation of secondary abscess or fecal fistula. In acute appendicitis, where the appendix was deep in the pelvis, he had had it rupture through a McBurney incision, so unless he could feel the mass he made a straight mid-rectus incision, which was closed completely as a rule and a counter-incision made for drainage.

DOCTOR ELIOT remarked that the opinion seemed to be unanimous that there was no need of a rectal or vaginal counter-opening in the drainage of pelvic abscesses. He believed that while post-operative irrigation was not entirely free from risk, the danger of the invasion of the general peritoneal cavity by the irrigating fluid was practically nil if a sufficient time—say four

or five days—were allowed to elapse before irrigation was begun, and if a non-irritating fluid—such as a normal saline solution—were employed at a very low pressure.

Doctor Eliot said his experience with the use of Dakin's solution did not coincide with that of Doctor Lilienthal. From his own observation, as well as from that of the House Surgeon, the use of the Carrel-Dakin solution in no way shortened the period of wound repair. He did not think the solution restricted the formation or hastened the separation of aponeurotic or muscular sloughs, and to these, and not to the intraperitoneal structures, he believed the sloughy formation to be harmful.

Doctor Eliot did not wish to assert that the use of the catheter in the treatment of abscess cavity was superior to the use of the instrument described by Doctor Lilienthal. He did wish to emphasize, however, that by the use of this device, dressings were entirely free from discomfort, and the healing of the abscess cavity was rapid and uneventful.

Stated Meeting Held May 11, 1921

Dr. John A. Hartwell in the Chair

THE VALUE OF CONSERVATIVE TREATMENT IN SARCOMA OF THE LONG BONES

Dr. William B. Coley presented the following cases:

Case I.—L. G., female, twenty-one years of age. *Central Sarcoma of the Lower End of the Femur,* with Extensive Involvement of the Knee-joint; mixed-giant- and spindle-celled sarcoma. (Full history with microphotograph published in the Annals of Surgery, March, 1917, p. 370.)

Amputation had been advised by every surgeon who saw the case, including Doctor Coley. Exploratory operation; toxins without other treatment for nearly one year. Complete recovery; two inches shortening. Well at present, with useful limb, six and a half years later.

Case II (see Annals of Surgery, March, 1917, p. 370).—C. F., female, seventeen years of age. *Central Sarcoma of the Upper End of Tibia;* mixed-, giant- and spindle-celled.

Admitted to the Memorial Hospital in August, 1915. Disease pronounced giant-celled sarcoma of epulis type, very moderate degree of malignancy, by Ewing; malignant by Barrie and Bloodgood. Curetting followed by toxins; three months later toxins discontinued on account of grippe; recurrence; second curetting; recurrence; again treated with toxins and one application of radium (pack) in addition. Complete recovery with useful limb; well at present, five and a half years later.

Case III (see Annals of Surgery, December, 1919).—L. D., male. *Sarcoma of the Lower End of the Radius;* complete destruction of two to three inches of bone; impossible to say definitely whether periosteal or central origin from the X-ray and clinical signs.

May, 1918, admitted to the Hospital for Ruptured and Crippled. Tumor of rapid growth; amputation advised by several surgeons. Complete recovery under

the systemic injections of the mixed toxins alone. Well at present, three years later, with perfectly useful arm. X-ray shows marked regeneration of bone.

AN UNREPORTED CASE OF SARCOMA OF THE TIBIA

CASE IV.—M. C., twenty-three years, of Hartford, Conn.

Family history negative. Admitted to the Hospital for Ruptured and Crippled on December 5, 1920. Previous history negative up to July 4, 1920, when she fell on a hard floor, injuring her knee and bruising her ankle. Two or three days after the accident she began to have pain in the upper end of the tibia, which gradually became worse. She remained in bed for two weeks, at the end of which time she could not stand or walk without causing intense pain. However, she kept about for four weeks, the pain gradually increasing in severity. She then consulted Doctor Sweet, of Hartford, who made a diagnosis of tuberculosis of the knee and put her in a plaster case. An X-ray picture was taken at this time. The case was kept on for six weeks, when it was removed and another X-ray picture taken. Three weeks later another X-ray picture was taken and a new case put on. Pain became markedly worse, so much so that she was unable to sleep nights. The patient lost some in weight and her general condition began to be affected. On December 7, 1920, she was referred to Doctor Coley by Doctor Burlingame.

At this time a careful examination of the X-ray pictures showed progressive destruction of the upper end of the tibia, with apparent involvement of the knee-joint. Clinical examination showed marked enlargement of the upper end of the tibia extending down about four and a half inches; the swelling was most marked anteriorly, was soft, semi-fluctuating, and apparently involved the knee-joint.

Diagnosis, based upon clinical symptoms and X-ray examinations: Central sarcoma with complete destruction of the upper end of the tibia and involvement of the knee-joint.

Treatment: Curetting followed by injections of the mixed toxins of erysipelas and bacillus prodigiosus. On December 7, 1920, under ether anæsthesia, a longitudinal incision was made, five inches in length, directly over the anterior portion of the upper end of the tibia and the knee-joint. Cutting through the skin and subcutaneous tissue, a tumor about the size of an orange was found in the upper end of the tibia, which completely destroyed the cartilage of the knee but which did not involve the femur. The old joint was disorganized and filled with fibrous, broken-down tissues; the tumor itself was largely cystic, containing five or six ounces of reddish-yellow fluid. The cavity was curetted out. Cavity extended down to the large vessels and great care was exercised not to injure them. After protecting the vessels the rest of the cavity was swabbed out with pure carbolic and alcohol. The cavity was then tightly packed with sterile gauze. A pathologic fracture developed about three inches below the upper end of the tibia, which was completely destroyed. Fibula was practically intact. The limb was put up in a plaster spica, extending down to the foot, under extension.

Three or four days after the operation the mixed-toxin treatment was begun, injections being made into the buttocks. After removal of the cast, four or five days later, the cavity was kept sterile with Dakin's fluid. The toxins were continued in increasing doses (beginning with one-half minim) up to the point of producing a severe reaction, temperature of 103° to 104°. The cavity healed rapidly with normal granulations and at the end of a week the spica plaster cast was removed. A shorter plaster splint extending to the upper portion of the thigh was put on and the wound dressed through a fenestra. The patient made an uninterrupted recovery.

X-ray photograph, taken every two or three weeks, showed a gradual decrease in the size of the large cavity, and the more recent photographs show beginning regeneration of bone. The patient is not yet allowed to walk or bear any weight on the limb. A modified Thomas splint is being made by Doctor Gibney, which will enable her to walk about without bearing any weight on the foot. At the end of three or four months it is expected she will be able to walk again without injurious effect to the limb. Her general health showing improvement under the treatment.

Up to the present she has had thirty-nine injections of the mixed toxins, beginning with one-half minim and increasing up to ten minims. Highest reaction =104°. Since last month she has been getting the toxins twice a week and later once a week, and it is my intention to continue the injections in small doses, not sufficient to produce a marked reaction, for a period of two or three months longer and then discontinue them altogether. The patient has had no other treatment than the toxins. It was intended to apply radium in case the disease was not quickly controlled by the toxins, but the progress of the patient was so rapid and satisfactory that it was decided to continue with the toxins alone.

Microscopic examination of the tumor removed (Doctor Jeffries): "Giant-celled sarcoma. The tissues exhibit a considerable degree of necrosis."

Microscopic examination (Barrie): "Definitely malignant tumor; fibro-sarcoma."

Microscopic examination (Doctor Ewing): "Giant-celled sarcoma, epulis type" (Fig. 1).

Clinically it was markedly malignant, inasmuch as it had destroyed the whole upper end of the tibia and the knee-joint in the short period of a little over four months.

GIANT-CELLED SARCOMA OF THE RIGHT RADIUS (HITHERTO UNREPORTED)

CASE V.—Mrs. M. F., forty years; family history negative. In June, 1919, she first noticed pain in the right wrist, shortly after which a swelling developed. There was no definite history of local trauma. Patient was obliged to give up work on July 1st, on account of the pain and swelling. Admitted to the Hospital for Ruptured and Crippled, Doctor Whitman's service, on November 29, 1919. An X-ray taken showed the lower end of the radius expanded by a tumor; cortex very thin, but the joint surface was apparently not perforated. Clinical diagnosis: Giant-celled sarcoma.

Operation December 1, 1919, by Doctor Kleinberg: The lower portion of the radius was found to have a very soft wall and to be movable, the point of mobility being about one inch above the styloid process. Below the point of mobility it was impossible to identify the periosteum. The central tumor occupying the whole lower end of the radius was carefuly curetted. The tissue was for the most part gray in color with occasional areas of white tissue. The articular surface of the radius was not pierced. Only a small area of the posterior wall of the radius was intact. The cavity was swabbed with pure carbolic acid and washed out with alcohol; cavity packed with gauze.

Pathological report by Doctor Jeffries (pathologist of the Hospital for Ruptured and Crippled): "Giant-celled sarcoma." A section (Fig. 2) was shown to Doctor Ewing, who pronounced it a giant-celled sarcoma of the epulis type. Dr. Geo. Barrie also examined the slides and pronounced it a hemorrhagic osteomyelitis. On December 12, 1919, the patient was transferred to Doctor Coley's service.

In view of the unanimous opinion of the three men, that it was a benign, giant-celled process and not a true malignant tumor, it was thought wise to make a test-case of it to determine whether or not it could be cured by simple curetting and carbolic acid, which, in the opinion of Doctor Bloodgood, is sufficient to cure practically all cases of benign, giant-celled sarcomas. The patient was discharged, and readmitted to the hospital on January 20, 1920. During the five weeks which had elapsed there was marked recurrence of the pain and the swelling had increased steadily. Examination showed marked enlargement at the site of the original lesion; there was false motion one and a half inches above the lower end of the radius, that is, pathologic fracture. Measurements over the lower end of the radius, eight and a quarter inches. Clinically, the tumor appeared to be malignant in spite of the pathological report. She was then put upon systemic injections of the mixed toxins of erysipelas and bacillus prodigiosus, beginning with one-half minim and increasing up to fourteen minims, producing reactions and temperature of 102–104°.

At the end of three or four weeks a decrease in the size of the tumor was noticed, which steadily continued until February 11, 1920, when the arm measured six and seven-eighths inches. In view of the fact that she had four children at home needing her care, she stated that she was unable to stay at the hospital and on February 21, 1920, she was discharged, apparently cured.

In the latter part of May, 1920, the lower end of the radius again began to increase in size, and slowly continued until July 1, 1920, when it had reached eight and one-quarter inches, the swelling apparently involving the radius for a distance of four and one-quarter inches (Fig. 3,A). She was shown at a conference at the Memorial Hospital, and, it being the belief of Doctor Ewing that this type of tumor would yield to radium, she was accordingly admitted at once, and radium treatment begun.

From July 2 to October 20, 1920, she received a total of 69,250 millicurie hours of radium, a very large dosage. The photographs taken on July 2nd (Figs. 4 and 5), compared with the ones taken on September 22nd, showed a very marked increase in the size of the tumor during the radium treatment, and X-ray pictures taken from time to time confirmed this increase in size. It seemed clear to Dr. Wm. S. Stone and Doctor Coley that there was no hope of getting control of the disease by the further use of radium and it was believed that amputation was the only thing left to do. Before amputation, however, it was decided to make one more trial with the toxins. She was accordingly readmitted to the Hospital for Ruptured and Crippled, and as she was unable to be away from her home, she was treated in the Out-patient Department, where she received toxins three times a week. The injections were pushed to the point of producing fairly well-marked reactions, which she bore well, and which did not interfere with her household duties. The treatment was carried out most faithfully by my House Surgeon, Dr. H. H. Shoulders, to whom belongs the credit for the results. All of the injections were made systemically in the buttocks. In less than two weeks the tumor began to decrease in size and the improvement has continued without interruption, until at the present time the tumor has almost entirely disappeared as far as X-ray and clinical evidence shows (Fig. 6). The toxins were discontinued about two months ago, since which time she has had no treatment. No X-ray, radium, or other treatment than the toxins has been given since October, 1920.

The circumference of the wrist at the site of the tumor, which in October was nine and three-quarters inches, now measures seven and a half inches.
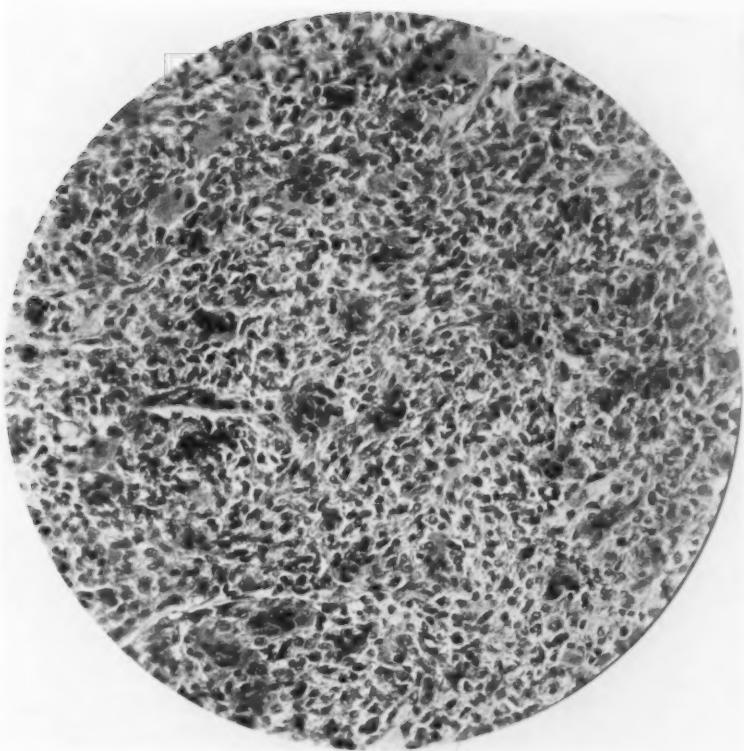
FIG. 1.—Microphotograph of section of tissue removed from tibia of Case IV.
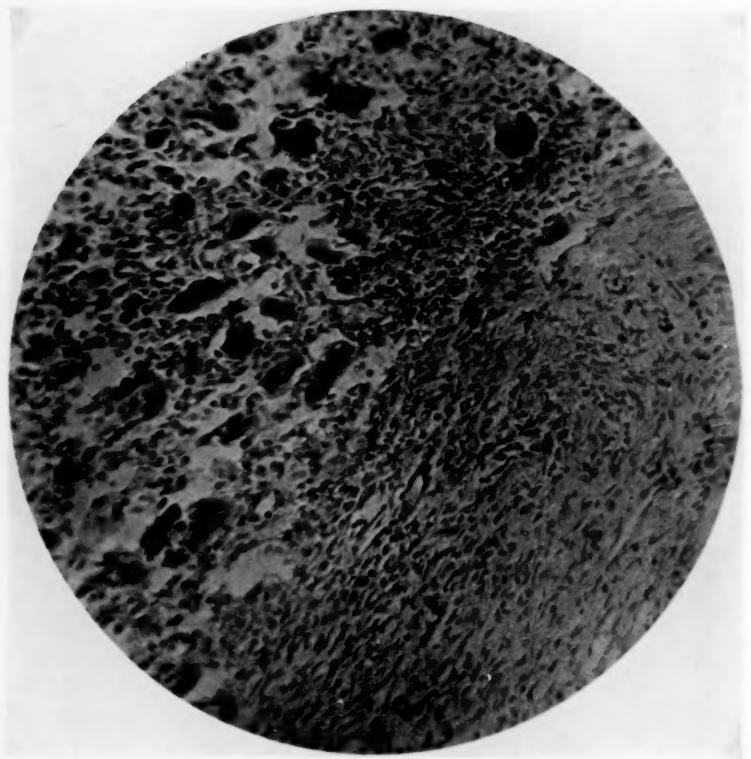
FIG. 2.—Microphotograph of section of tissue removed from growth in base of radius in Case V, M. F.
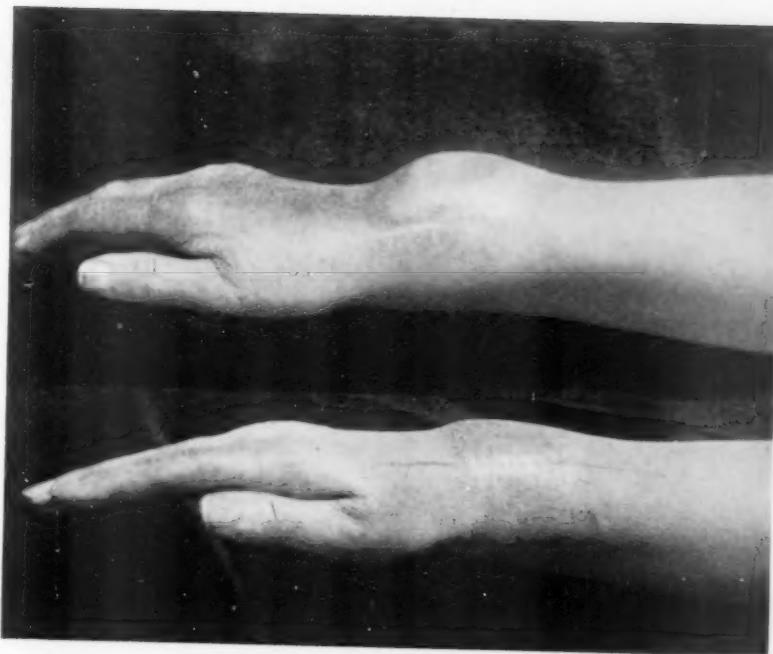
FIG. 3.—Case V, M. F. A, condition July 22, 1920; B, May 5, 1921.
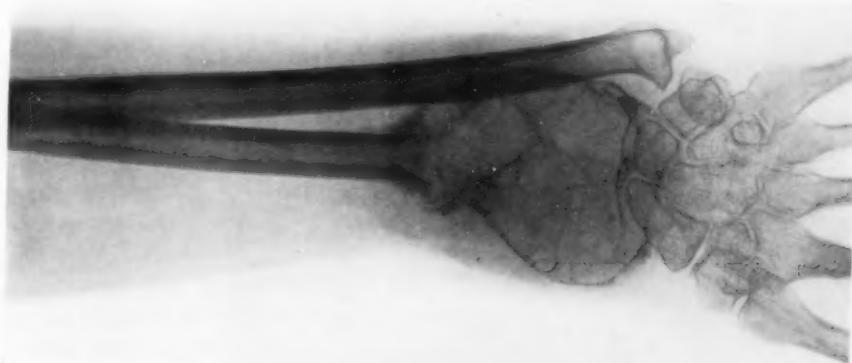
FIG. 4.—Case V, M. F. Condition September 22, 1920, after three and one-half months of radium treatment.
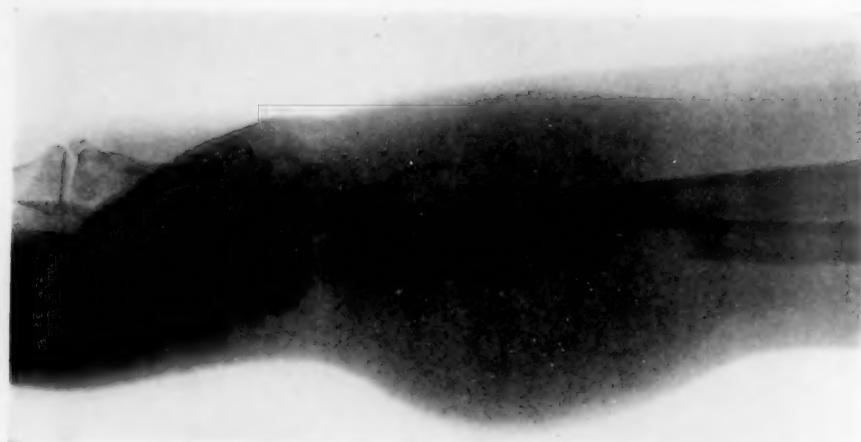
Fig. 5.—Case V, M. F. Condition September 22, 1920, after three and one-half months of radium treatment.

Fig. 6.—Case V, M. F. Condition eight months after resumption of toxins, Tumor has nearly disappeared and function of hand is nearly restored.

In view of the tendency of the disease to return it is intended to give her another course of toxin-treatment in the near future lasting for a period of two to three months.

It would be unwise at present to say anything definite as to the final outcome.

(Series of photographs illustrate this case.)

Dr. Virgil P. Gibney said he had seen a great many of Doctor Coley's cases, and had the opportunity of watching them from start to the finish, and usually seeing the end results. The most remarkable of Doctor Coley's cases was one he saw in the Montefiore Home some twenty or thirty years ago, in which a part of the spinal column was disorganized and the condition supposed to be an abscess from Pott's disease, but it proved to be malignant. The patient was a young man nineteen or twenty years of age. Doctor Coley apparently cured him and the man is well to-day. The majority of his results had gone on wonderfully well, so that Doctor Gibney felt when he saw a case of sarcoma that he wanted Doctor Coley to use radium and the toxins.

Dr. John A. Hartwell stated that the important point was to classify these cases according to their malignancy. The whole subject of osteosarcoma was so confused as to the nature of the disease that until the pathologists and physicians together arrived at a classification it was very difficult to draw conclusions from a demonstration of patients who had remained cured in any form of osteosarcoma. The microscopical examination was so difficult in many cases that even several sections from the same patients studied by the same and by different pathologists failed to demonstrate what the disease was. As Doctor Coley had pointed out, there were very marked differences of opinion as to the so-called giant-celled type of sarcoma; some were very benign and some were quite malignant; some responded to mixed toxins and some responded to radium or to curettement, while others that had the same appearance as the ones cured by these methods did not respond to treatment and appeared to be exceedingly malignant.

As to the X-ray diagnosis of osteosarcoma, it was always very unsatisfactory. There were instances at a recent conference in which Doctor Bloodgood, Doctor Ewing and Doctor Codman were in doubt as to whether the condition should be classified as benign or malignant. Doctor Codman has formed a register of all cases of sarcoma that he could obtain. He asked that any surgeon who might have a case in which there was reasonable evidence, either X-ray, microscopical, or clinical, that the condition was sarcoma, be recorded with him. If one sent a card to Doctor Codman he would send the particulars as to how to register the case. He would also be glad in any case of suspected sarcoma to give aid in making the diagnosis and suggestions for treatment.

Doctor Coley stated that he had radiographs of a patient who had a large tumor of the lower end of the radius which had completely broken through the bony shell, and he then presented them. He stated that the

history of the case had been reported in full in the ANNALS OF SURGERY
(December, 1919). While it was impossible to tell from an examination
of the X-ray picture the degree of malignancy of the tumor, it differed
from the ordinary giant-celled central tumor in that it had completely de-
stroyed the entire bony shell. Clinically, it was malignant, as it was of
comparatively short duration. Doctor Coley said he was glad Doctor Hart-
well had brought out the difficulty in making a diagnosis in sarcoma of the
long bones. He said that for more than thirty years he had been making a
study of sarcoma of the long bones, clinically and microscopically, and later
by the additional aid of the X-rays, and that there was yet much about the
subject requiring further light. Personally he believed we were much more
likely to arrive at a correct conclusion by a careful study of a very large
number of cases treated at a single institution in which the clinical and
pathological studies were conducted by the same group of men. He person-
ally had observed about 300 cases of sarcoma of the long bones, and all of
the specimens removed either by amputation or curetting had been carefully
preserved at the laboratory of the Cornell University Medical School or at
the Memorial Hospital. These specimens and the microscopical sections
from them are all carefully kept on file, making it possible to study them. He
believes that one could get more accurate data from a study of this large
group of cases than would be possible from a larger number of cases collected
indiscriminately from different observers, many of whom have seen but a
single case or, at the most, but a very limited number. The clinical and X-ray
evidence was often of equal or even greater importance than the pathological
examination. The locality of the tumor in sarcoma of the long bones plays
an important part; there are certain bones, *e.g.*, the humerus, in which it
makes little difference whether the tumor be of periosteal or central origin,
or whether the specimen histologically showed giant-cells or none at all.
Sarcomas of the femur and humerus are extremely malignant. At a sym-
posium on Sarcoma of the Long Bones, before the Royal Society of Medicine
in London, November, 1912, it was brought out that not a single case of
sarcoma of the humerus, at St. Thomas' and St. Bartholomew's Hospitals,
had been saved by shoulder-joint amputation. Butlin's very extensive statis-
tics collected from the literature, showed almost no cases of sarcoma of the
humerus remaining well for three years after amputation. The same is
largely true of sarcoma of the femur, nearly all cases being malignant, whether
of myeloid or periosteal type.

Doctor Coley has long held the opinion that, while one could state posi-
tively that practically all tumors of the periosteal type are malignant, it was
not always possible from the microscopical examination to determine the
degree of malignancy of central sarcomas of the long bones; that, while some
of the central tumors with abundant giant-cells and a few spindle-cells, espe-
cially of the upper end of the tibia or lower end of the radius, could be
classed as benign or nearly benign, there are other cases in which the histo-

logical picture so closely resembles the former they can scarcely be differ-entiated, which recur after operation and kill the patient by metastases. Doc-tor Coley showed several lantern slides of microphotographs of giant-celled sarcomas in support of this view.

Doctor Coley stated that he, up to the present time, had succeeded in saving the leg or arm in eighteen cases of sarcoma of the long bones; twelve by the use of the mixed toxins of erysipelas and bacillus prodigiosus, and six by a combination of the toxins and radium or toxins and X-rays. He believes that the best results in the future will be obtained by combining the systemic effect of the toxins with the local effect of the radium. During the past seven years, at the Memorial Hospital, an attempt has been made to try out the different methods of treating sarcoma of the long bones. Doctor Coley added that the results of amputation are too well known to need further comment, that practically all of the periosteal cases proved fatal in spite of high amputation and only a small percentage of the central sarcomas, those of the myeloid type, have remained well beyond three years from amputa-tion. Doctor Coley stated that a series of cases at the Memorial Hospital have been treated with toxins alone, another series by radium alone, another by toxins and radium combined, and a fourth by toxins following amputation. These results will be published in a series of 125 cases in full in a report which the Memorial Hospital will issue in the near future.

SYPHILITIC OSTEOMYELITIS OF THE FEMUR

Dr. F. W. BANCRFOT presented a woman, who was admitted to the New York Hospital, December 16, 1920, on account of a swelling of the left knee of three months' duration. Three months ago while on an ocean steamer she fell on her knee, and upon rising could not walk without assistance. An hour later she began to have pain and the knee became swollen. The pain had persisted ever since. She had been treated for the three months before she came under his observation. When she came to the dispensary she had fluid in the knee-joint, no night spasm and no particular pain. She was feeling fairly well. The knee was aspirated and guinea-pig injected. The Wassermann reaction was positive; the blood count normal. X-ray pic-tures taken in the anteroposterior and lateral position showed the condition. While in the hospital the patient was given two doses of neosalvarsan and since that time anti-luetic treatment had been continued. The X-ray picture, taken April 18, 1921, showed the production of new bone and a diminution of the rarefaction shown in the first pictures. Besides the anti-luetic treatment she had received no treatment whatever. The fluid had not reaccumulated in the knee. There was normal motion and very little deformity.

In his description of syphilitic osteomyelitis McCallum says: " Gummata formed in the marrow cavity are of sufficiently frequent occurrence, although they were practically overlooked until Chiari demonstrated their existence. They are gelatinous patches, often bright yellow from their content of fat, which may occur singly or in such numbers and continuity as to involve

the whole marrow cavity. Generally there is no outward evidence of their existence, but the cortex may be attacked and eroded and the periosteum outside produce a new layer of bone to correspond. In this way there may be a spindle-shaped dilatation of the bone; canals or fistulæ are formed through the cortex, and except for the absence of sequestra, the bone comes to look like the end result of an ordinary osteomyelitis."

Doctor Bancroft said the X-ray diagnosis was given as tuberculosis, but the patient had no elevation of temperature, no night spasm, and there was no pain, and the Wassermann was positive both by the cholesterin and alcohol methods. Then the lesion was on the diaphyseal side of the epiphysis which was against its being tuberculous.

OSTEOMYELITIS OF THE TIBIA

Dr. John A. Hartwell presented a woman twenty-five years of age, who was admitted to Bellevue Hospital, December 23, 1919, with the history that when she was ten years old, she had an abscess over the internal aspect of the tibia, but could not relate the details in regard to it. This had been healed many years, but she had recently had pain over the lower end of the fibula. The X-ray showed osteomyelitis of the lower one-third of the tibia (Fig. 1). The fibula was normal. There was distinct tenderness with depression of bone at the site of the old abscess and slight thickening over the surface of the fibula.

Operation on January 4, 1920, showed abscess in the bone two inches above the right internal malleolus, with sclerosis of the medullary canal (a Brodie abscess). There was no evidence of bone disease of the fibula. The abscess cavity was curetted after removal of the cortex and the muscles allowed to drop into it. Culture showed Staphylococcus aureus. The cavity was dakinized. The patient was discharged March 29, 1920, with the wound entirely healed and only slight œdema. She was advised to use crutches and not to put any weight on the foot.

On May 9, 1920, the patient returned, complaining of pain but no tenderness or redness in the lower end of the radius. The X-ray showed a localized area of rarefaction, and a provisional diagnosis of bone abscess was made.

August 23, 1920, she was readmitted for the wrist condition (Fig. 2), which showed a tender swollen point at the end of the forearm over the radius.

Operation on the following day showed a collection of pus about one-half inch from the articular surface of the radius. The abscess cavity was curetted and packed with vaseline gauze. A culture of the pus from the abscess cavity showed Staphylococcus aureus.

On October 1, 1920, she was again operated upon for recurrence of the abscess at the site of the previous abscess of the tibia; two small pockets of infected granulation tissue were found. These pockets were curetted into

one connecting cavity and all necrosed bone removed. The wound was left wide open and dakinized with the idea of doing a fat graft when the wound was sterilized.

Operation on October 22, 1920, showed the cavity lined with healthy granulation tissue, except one pin-head point at the lower end, where the granulations were slightly grayish. The bacteria count at the time on three successive days showed one in five fields. A fat graft from the upper part of the thigh, twice the size of the cavity, was compressed into the cavity and the skin edges sutured over it. Primary union resulted.

On November 23, 1920, examination showed that pain, tenderness and swelling had recurred. The X-ray showed a recurrence of the localized area of bone destruction at the outer half of the lower extremity of the radius (Fig. 3). The leg wound was in good condition, the fat graft having apparently lived and filled the bone defect.

Operation, November 23, 1920, showed in the lower end of the radius a cavity left from the previous operation filled with pus and soft spongy granulations. The cavity was exposed by chiseling away part of the cortex. The cavity was curetted and dakinized with the idea of doing a future fat graft. Cultures of the pus showed the Staphylococcus aureus.

A fat graft was found unnecessary because the cavity in the radius completely healed, and the patient was discharged with normal motion in the wrist-joint on January 14, 1921. The left leg was entirely healed, but with slight œdema about the ankle.

On February 27th, the X-ray showed regeneration of the bone in the periosteum covering the implant and also a marked network of bony growth in the substance of the fat implant. There was also a sclerosing osteomyelitis and periosteitis of the lower end of the fibula, but no evidence of inflammation. These evidences of complete healing were still more marked in the X-ray taken May 7th.

The Bellevue Hospital pathologist's report on the specimen taken October 1, 1920,—curettings from the cancellous tissue of the tibia—is "chronic productive osteomyelitis."

The interest in the case centres about the regeneration of bone fin the fat transplant as shown in the X-ray.

Doctor Bancroft said there were three things quite clear which a bone graft must do: (1) It must bridge the defect and it must prevent deformity of the limb. (2) It must be of such a size and shape that the blood supply could be quickly established. (3) It must act as a stimulant for osteogenesis. With the Delageniere graft the part can be immobilized and the blood supply was easily established through the small bone fragments of the osteoperiosteal graft. As to the third point, there was a larger surface of raw bone with this kind of graft, and he believed that the large raw surface did more toward the stimulation of osteogenesis than any other factor. He believed that the failure of the medullary graft was due to the fact the blood supply

was cut off through the medullary nutrient artery, and for that reason failed. The inlay grafts did not interfere with the blood supply coming through the medullary canal and they exposed more surface of bone. He believed the Delageniere method was largely successful because a larger area of raw bone was exposed which stimulated osteogenesis, and there was no interference with the blood supply.

BONE GRAFTS FOR DEFECTS IN LOWER JAW

DR. C. A. McWILLIAMS presented a man, now (Fig. 7) twenty-four years of age, who was reported in the ANNALS OF SURGERY, vol. lxv, 1917, p. 290, who had a defect in the lower jaw, the result of a discharge from a shot-gun. It illustrates the well-known fact that infection, and even sequestration, does not necessarily mean the non-success of the formation of new bone as a result of grafting. On June 7, 1916, the defect was laid bare, many buck-shot were removed, the ends of the fragments were freshened, and two fur-rows were cut along the outer surfaces of the two fragments. Two drill holes were cut going into each furrow; an inlay graft from the tibia with its periosteum was laid into the furrows and fastened in place with kangaroo tendon. The skin over the graft was very thin and was evidently stretched too tight, for two weeks after the operation there was some necrosis of the skin edges, exposing the graft beneath. The opening never closed. For three months the upper and lower teeth were maintained immovable by wiring them. Three months after the operation a sequestrum, the whole length of the graft, was lifted out of the enlarged wound, which then soon healed, leav-ing an ugly depression in the side of the lower cheek. This was filled out with a pedicled flap from the forearm which was held to the side of the head by a plaster-of-Paris bandage for nine days, when the pedicle was severed. The skin graft healed in nicely, as you can see now. The bone graft prolifer-ated finely, as you can now feel the solid bony ramus and see it by the X-ray. Mastication is perfect. In this case suppuration and sequestration did not seem to have any deleterious influence on the formation of new bone. As is seen in the radiograms, many buckshot have remained in the tissues for all these years without any deleterious ill-effects.

The second case was an Italian woman of forty-six years of age, pre-viously reported in the ANNALS OF SURGERY, vol. lxv, 1917, p. 289. The result of consolidation of the edges of a defect in the lower jaw, the result of osteomyelitis, was such a bad position that chewing was impossible. The site of consolidation was chiselled through, the fragments were separated, and a bone graft was inserted, end-to-end without inlay, and fastened in place with metal sutures. Because of infection the graft had to be entirely removed with the wires holding it. A second bone graft operation was performed on May 18, 1915. A graft, with periosteum from the tibia, was inserted end-to-end without inlaying with kangaroo tendon. The upper and lower teeth were wired together and this was maintained until October 1, 1915, four months. The wound healed kindly; the patient went home.
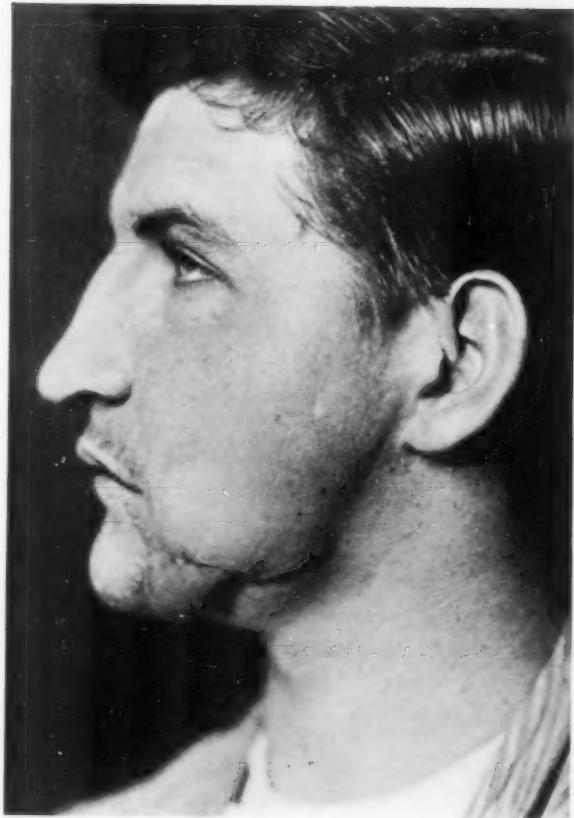
Fig. 7.—Ultimate result in restoring defect of the lower jaw.
(McWilliams.)

FIG. 8.—Case I. Five years after operation.

FIG. 9.—Condition of graft for defect in lower jaw six years after operation. (McWilliams' Case II.)

Three weeks after the second grafting operation, she fell and broke the tibia, from which the graft had been taken. The crest of the tibia had been erroneously included in the graft. Splints were applied and healing of the fracture occurred as usual. It is now six years since the operation and you can feel both the sense of touch and of sight, and the radiogram, shows that there is a firm, lower ramus of the lower jaw at least an inch in its vertical diameter.

He said that in case he again had a bony defect of the lower jaw to graft, and this also is true of graftings anywhere, he would use the osteoperiosteal method of Delageniere, which has given the French surgeons such excellent results. He would fill in the space between the bone ends with bone chips from the tibia, and over the chips, on the two sides of the bared fragments, he would apply one or two strips of periosteum attached to which should be left plaques of bone, raised up from the tibia by a chisel. The successes with this method are greater than with the English end-to-end method, or even with the American inlay method. In addition, it is much the easiest and simplest method, doing away with complicated motor saws. This method should be more widely used in America, and, if an inlay graft were used, it could well be supplemented by an osteoperiosteal strip over the graft or placed on the opposite side of the fragments. Among 1390 graftings there were 82 per cent. successful, and the proportion of successes was the same whether periosteum was on the grafts or not. There were 87 per cent. of successes with the osteoperiosteal method, 82 per cent. of successes with the end-to-end without inlaying, 80 per cent. with the inlay method, and 76 per cent. with the Murphy intramedullary procedure. In my opinion the intramedullary method should be discarded in favor of the osteoperiosteal method.

BONE GRAFTING FOR SADDLE NOSE

Dr. C. A. McWilliams presented a man now thirty years of age, who was reported in the Annals of Surgery, vol. lxv, 1917, 789, having been operated upon, April 20, 1915. He had received a kick from a horse upon the bridge of the nose, fracturing and depressing its middle portion, producing a saddle nose. Two portions of a rib, with the periosteum on one side, were transplanted, one in front of the other, into a tunnel made down the front of the nose through a curvilinear incision across the root of the nose just where the cross-bar of spectacles would rest. There was primary union. The patient is presented now, after six years, to show that the primary, good, cosmetic result has remained as at first. The scar is not distinguishable. The rib grafts can be felt persisting as large as when transplanted, and they are so firmly attached to the frontal bone that they cannot be moved.

Doctor McWilliams presented also a boy, now sixteen years of age, who had had a saddle nose, the result of inherited syphilis. He was operated upon one year ago. The reporter said that his first three graftings for saddle nose were made with bone from the ribs. Since then he had used

costal cartilage. He has now performed five with costal cartilage, a method which offers many advantages over bone transplants in the nose. (1) It can be easily moulded to any shape with the knife. (2) If suppuration occurs, as may easily happen because of some unforeseen and undetected opening into the nasal cavities, cartilage resists infection much better than bone. He had had three cases of costal grafts suppurate, and the cartilage remained *in situ* and lived after the infection had subsided, while in the third it sloughed out, after which the costal grafting was repeated with success.

In this boy the costal rib graft was slipped in as in the previous case. Slight suppuration occurred, but the effect on the cartilage was nil. The graft has persisted and the cosmetic effect is all that could be desired.

In reply to a question, Doctor McWilliams said that he would not advise bone grafting except as a last resort. The greatest application was in non-union of fractures. If one were going to operate simply for malposition, some other method would be better than bone grafting. The only adequate method of treating non-union was by bone grafting. The only other place where a bone graft should be used was where the defect was so great that the bone would not fill it normally. The 17 or 18 per cent. of failures indicated that we did not know much about osteogenesis, we did know the chemistry or the physiology of osteogenesis; we were in the dark about its rationale. Doctor Neuhof had transplanted fascia lata into the bladder, stomach and ureteral walls; that was where the conditions were acid and had regularly gotten bone formed in the transplants. This much Doctor McWilliams said was certain, bone was formed out of connective tissue. Osteoblasts were indistinguishable from fibroblasts; then was deposited calcium which was the beginning of bone formation. With all the methods of bone grafting, there were 18 per cent. of failures. It was one of the most disappointing things to have a bone graft heal in aseptically and then gradually melt away in the tissues. He now had under observation a case of intramedullary graft which had healed without suppuration, but there was still non-union, because the graft had been absorbed.

BOOK REVIEWS

SELECTED LECTURES AND ESSAYS.   By SIR JOHN BLAND-SUTTON.   William Heinemann.

This book opens with the story of the tendons and ligaments which was published many years ago by the author, showing the origin of many vestigial structures in man, and tracing them back among the lower animals. Most of those who studied anatomy twenty years ago will be familiar with these first few chapters.   In them, the author shows not only that wide knowledge of anatomy which is associated with his name, but also a happiness of imagination in connection with certain speculative theories. He passes from ligaments to gizzards, from gizzards to calculi with equal facility.   The chapter on " Post-mortem Digestion of the Stomach " is, in itself, of the greatest interest, reviewing, as it does, some of Hunter's original work.

In Chapter XVII he discusses ulcers of the duodenum and stomach, and here again his views are interesting and original, though many will be found to disagree with his conclusions as to the advisability of resection of the pylorus as a routine operation.   He next passes to injuries of the heart, and gives in detail the first recorded case, described by Dr. Guido Farina.

Missiles as emboli follow in the next.   Then he turns his active and varied intellect towards the various sexual characters and malformations found in man and animals.   Tubal abortion and tubal rupture have a chapter to themselves, while the history of the development of the antlers in bucks, and of circumcision, as a rite and as a surgical operation, are fascinating reading; this latter is accompanied by reproductions of reliefs from the Egyptian tombs, and numerous quotations from the Apocrypha.

Leaving surgery and anatomy for the moment, he enters the bull-ring, and gives us an admirable description of the work of the various performers and the reasons of their particular movements, each and all of which are destined to tire out the powerful muscles of the neck of the bull until he exposes the vulnerable point through which the matador can drive his sword.   As this is an interspace with an average measurement of 4 cm., between the neck of the first rib and the transverse process of the vertebra with which the head of the rib articulates, some idea of the courage and dexterity and coolness demanded may be gathered.

Pulque and pulque-drinking next receives attention, while Chapters XXX to XXXIII are concerned with the medicine of the Bible, in which the author explains many of the curious occurrences therein recorded.

The last chapters conclude with the tale of a convoy.   We understand that, in order to gain local knowledge and color, the author spent one of

his hard-earned holidays during the war as a passenger on board one of the convoying vessels. It is admirably human and true.

Where all is so good, it is difficult to select any special portion for praise; certainly the book is one which everybody should read, as it is a true education to do so. A versatility that can range from ligaments to antlers, from antlers to Egyptians, from Egyptians to pulque, from pulque to the Bible, and from the Bible to the war, must excite our envy and admiration. The book is well written, excellently illustrated, full of happy quotations, and throughout there is an under-current of humor which is not its least valuable asset. Indeed, one can conclude this review in the words, quoted by the author himself in connection with Yorick, that " he is a fellow of infinite jest and most excellent fancy."

WM. CLAYTON GREENE.

LIFE AND TIMES OF AMBROISE PARÉ, with a new translation of his Apology, and an account of his Journeys in Divers Places. By FRANCIS R. PACKARD, M.D. Octavo, cloth, 297 pages. New York, Paul B. Hoeber, 1921.

The character and career of the man, the times and the part that Paré played in them will never cease to be of interest as long as the records of history endure and men continue to admire sterling integrity, unremitting devotion to duty and fearlessness of daily walk among countless snares and pitfalls, coupled with force, power, originality, foresight that render a man superior to the limitations that bind his fellows and make him the pioneer of a new era. For all this and more was Ambroise Paré. Paré was not only a great man and by nature endowed with the surgical genius, but he had both an instinct and an aptitude for writing that was a remarkable gift. A natural gift it was, for no training nor urge from others brought it into being. As a result no surgeon of his time is so well known, or has exercised such an abiding and beneficent influence on the healing art. There is no one in the annals of surgery that approaches him in all the elements of a well-balanced symmetrical character. In the book before us Doctor Packard gives an excellent digest of all that is known of Paré from his birth at Laval, to the day of his death in Paris, eighty years later, the favorite of princes, the confident of queens, the counsellor of kings and the friend of the helpless everywhere. It is difficult to add much if anything about Paré to the facts assembled by Malgaigne in his comprehensive introduction to his editon of *Oeuvres Completes,* published in 1840. Stephen Paget in his charming book on Paré and his times, by the Putnams, published in 1897, has given us in an English dress this whole story, but both these books are out of print. The present generation owes a debt of gratitude to the energy and interest of Doctor Packard and the public spirit of Mr. Hoeber that this new study of an ancient theme is made available to it.

LEWIS S. PILCHER.

DIATHERMY. By ELKIN P. CUMBERBATCH. William Heinemann.

This is a book which deals with a new method of treating disease. As the term implies, it is a " through heating," in which an electric current of a special kind, generated by a special machine, traverses the body. The tissues are supposed to be heated *throughout*.

The book opens with a historical note dealing with the work of Tesler and D'Arsonval, following a discussion of Nagelschmidt's method, who was really the first to introduce and popularize this method of treatment in this country. Various forms of the apparatus are described in detail, and careful illustrations are given, showing the method by which the sparks are obtained.

Chapter V deals with the physiological effects of diathermy, and it is pointed out that there is a very definite reaction on the part of the tissues to the current. Alterations in the blood-pressure are noticed; in one instance there was a fall of 10° in the systolic blood-pressure, while other charts illustrate the fact that there is a definite increase in the temperature. Generally speaking, as the result of the experiments described in Chapter VI, there is an elevation of temperature varying from 2° to 9°.

Chapter VII deals with medical diathermy, in which the therapeutic effects of heat are distributed generally, either to the body as a whole or to the part affected. Careful details are supplied as to the method of application of electrodes, and indications as to the strength of the current required for various conditions.

Sections iii, iv and v of this chapter deal with some of the medical conditions for which diathermy has been used with considerable benefit, and they include circulatory disturbances, neuritis, sciatica, arteriosclerosis, paralysis agitans, gonorrhœal infections.

Chapter VIII considers the use of diathermy in surgery, and opens with an illustration indicating the amount of destruction which is caused when the active electrode is placed in contact with the tissues. In diathermy the electrode is cold when it is placed on or in the tissues, and remains cold until the current passes to it from the negative electrode. Anyone who has seen the cauterizing effect of this diathermy in surgical conditions must be astonished at the wide area of destruction created. Illustrations of the different forms of electrodes for use are figured, and details are given as to their methods of application.

In section iv the treatment of cases by diathermy is described, and the attention of the reader is directed to the danger of using this process of cauterization in the neighborhood of large arterial channels, which must always be ligatured as a preliminary; otherwise dangerous, even fatal, secondary hemorrhage may supervene.

In section v particulars of some cases treated are given; growths of the mouth and throat, of the palate, tonsil; inoperable carcinoma of the breast, rodent ulcer, warts, and papillomata of the bladder. It is in connec-

tion with this latter affection that diathermy finds one of its greatest uses in surgery.

The book is well printed, the illustrations are clear, there is an efficient index, and the author is modest in his claims on behalf of what is, at present, an experimental method of treatment. The method, however, will undoubtedly fill an important place in the therapeutics of both medicine and surgery.

WM. CLAYTON GREENE.

MANUAL OF OPERATIVE SURGERY. By JOHN FAIRBAIRN BINNIE. Eighth edition, revised and enlarged, 1921, large octavo, 1311 pages, cloth. Philadelphia, P. Blakiston's Son and Co.

The steady growth in importance and dignity of Doctor Binnie's book indicates not only the activity and industry of the author, but also the larger scope which the author has desired it to occupy and above all the even greater growth in the surgical activities of recent years.

The original modest pocket handbook of 1904 has now grown into a large and imposing volume, densely packed with material.

Doctor Binnie has a genius for condensation and he has evidently endeavored to gather into his book everything of importance pertaining to operative surgery which surgical literature up to date has brought to his hands. He has succeeded admirably in his purpose and has condensed into one book the contents of a whole library. That his effort has met with the approval of surgeons is evident by the regular appearance of new editions. We can but hope that the accomplished author may be spared for many years to carry on his work for successive classes of surgical practitioners.

LEWIS S. PILCHER.

INFECTIONS OF THE HAND. By ALLAN KANAVEL. Fourth edition, 8vo, 500 pages, cloth, 1921. Lea and Febiger, Philadelphia.

This revised edition of Doctor Kanavel's studies upon infections of the band will be welcome. The importance of the study will be recognized by all, for the crippling effects of hand infections are among the most common lamentable surgical sequelæ with which everyone is familiar. People do not often die as the result of infections of the hand and forearm, although they sometimes do. It is refreshing to turn from the surgery of the great cavities and viscera of the body to the common, ordinary, everyday subject of felons and abscesses. The author has approached his subject in a systematic way and has treated it with much thoroughness and skill. We commend this book even to experienced surgeons.

LEWIS S. PILCHER.

FRACTURES. By JOHN B. ROBERTS and JAMES A. KELLY. 1921. Second edition. J. B. Lippincott Company, Philadelphia and London.

This edition is made up of 755 pages with 1081 drawings, radiograms and photographs.

This book supplies the reader with a clear, concise, and systematic presentation of the subject of fractures. It begins with a chapter on "General Considerations" and is closed with a treatise on "Industrial and War Fractures." Between these two chapters there is a complete and comprehensive description, accompanied by radiograms, or drawings, together with the accepted treatment of every type of fracture to which the bones of the human body may fall heir.

A few of the fundamental principles as set forth in this book seem worthy of presentation, however, at this time. Gentle handling is of the utmost importance. Radiograms of every case, and a general anæsthetic in most every case are essentials. Early mobilization of fractures in or near joints is urged. It should be begun within the first twenty-four or forty-eight hours. The skin, the muscles and the neighboring joints must have not only early but constant attention. Some form of suspension, traction and counter-traction is the treatment of choice, especially in fractures of the femur and tibia. The majority of fractures of long bones do not require operative interference. Functional restoration is of more importance than anatomical contour. Open fractures usually require an operation so that a contaminated fracture may be converted into an aseptic fracture. This is best done within the first eight to ten hours after injury. If a closed fracture requires operation wait seven days after injury, if possible. Small fragments of bone in comminuted fractures should not be removed as they furnish centres of callus deposition. Ambulatory dressings are advised in every possible case. The Thomas splint is the apparatus par excellence to be used in the transportation of fractures of the arm or leg. However, the authors believe that all splints, appliances, and apparatus available will in no way replace a thorough knowledge of the anatomy, pathology, and mechanics, without which the so-called "surgical grasp," which is so necessary in treating the individual fracture, is lost.

MERRILL N. FOOTE.

A MANUAL OF SURGICAL ANATOMY. By CHARLES R. WHITTAKER, F.R.C.S. (ED.). Third edition. New York, William Wood and Co. Edinburgh, E. and S. Livingstone. 1921.

The last or third edition of this book appears enlarged and revised and is found to contain many new illustrations. As its title implies, it is essentially a book for undergraduate work, but may, however, be profitably read and digested by the surgeon and internist.

The entire subject of surgical anatomy is thoroughly covered and is presented in a most interesting and instructive manner. To the student, as a supplement to his work in the dissecting room and to the use of his text-books on anatomy, and to the surgeon, as a means with which briefly to refresh his knowledge of the essential anatomy of the part to be operated, this book is highly recommended.

MERRILL N. FOOTE.

BOOK REVIEWS

AIDS TO OPERATIVE SURGERY. By H. C. ORRIN, F.R.C.S.(ED.). William Wood and Company, 1921, New York.

This small book of 236 pages has been written and published especially for the student preparing for his final examinations in surgery in the medical school. It is in no sense to be regarded as a text-book on operative surgery. It does, however, fulfill a real purpose, in that it gives to the student, in the most concise manner, the steps of the various surgical procedures. The subject matter is systematically arranged. At least one method of doing every conceivable operation is described. Brevity combined with thoroughness seems to have been the author's aim. It is an epitome, confined to the salient features and essential facts of the operations of surgery.

MERRILL N. FOOTE.